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ERRATA.

Page 51,	line 11,	for "p. 74"	read "p. 721."
" 88,	" 25,	" "*Empis tesselata*"	" "*Empis tessellata.*"
" 97,	" 24,	" "Mr. M. H. Dawe"	" "Mr. M. T. Dawe."
" 120,	" 29,	" "Prof. Buguion"	" "Prof. Bugnion."
" 158,	" 23,	" "Dr. J. O. Murphy"	" "Dr. J. C. Murphy."
" 171,	" 22,	" "*O. nigrocephalus*"	" "*O. nigricephalus.*"
" 182,	" 36,	" "*Dicorcelium*"	" "*Dicrocoelium.*"
" 183,	" 2,	" "*Echinorynchus*"	" "*Echinorhynchus.*"
" 189,	" 37,	" "*domestica*"	" "*domesticus.*"
" 189,	" 39,	" "*Crux*"	" "*Crax.*"
" 234,	" 13,	" "tos*Pentelicus*"	" "to *Pentelicus.*"
" 238,	" 29,	" "*Tephrosia vogilii*"	" "*Tephrosia vogelii.*"
" 262,	" 36,	" "*Haemogogus*"	" "*Haemagogus.*"
" 355,	" 28,	" "Coupida"	" "Courida."
" 363,	" 4,	" "*sylvestrii*"	" "*silvestrii.*"
" 366,	" 17,	" "*Mimusops globosa*"	" "*Couroupita guianensis.*"
" 400,	" 16,	" "*Xenopsylla cheopsi*"	" "*Xenopsylla cheopis.*"

IMPERIAL BUREAU OF ENTOMOLOGY.

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NEW CULICINE LARVAE FROM THE GOLD COAST.

By J. W. SCOTT MACFIE, M.A., and A. INGRAM,

West African Medical Staff.

Since Mr. F. W. Edwards' "Revised Keys to the known larvae of Africa Culicinae" appeared (Bull. Ent. Res. iii, pp. 373–385) the larvae of several additiona species—all belonging to the tribe CULICINI—have been found in the Gold Coas Colony. These larvae, collected at Accra and at Sunyani in Ashanti, are briefl described here and their position in Mr. Edwards' keys indicated so far as possible

Stegomyia metallica, Edw. (fig. 1).

The larva is dark in colour with prominent hook-like spines on the ventro-latera aspect of the thorax; these spines are much larger than the corresponding spines i *S. fasciata.* The head is small, the antennae are short, with a single hair in place of a tuft and the mid-frontal hairs are simple single bristles. There are numerous stellat hairs on the thorax and the abdominal segments, a certain number of the stoute hairs on the abdomen are branched and rise from pedicles; these stouter hairs ar subplumose at their bases. The comb consists of 6–10 barbed spines,* the subsi phonal and siphonal plumes are of subplumose hairs. The siphon, which is barrel shaped, is in length just over twice the diameter of its base; the pecten, runnin somewhat diagonally, is formed of from 12–14 spines and a hair-tuft of four hairs i placed at or just beyond the middle; a detached spine may occur beyond this hair tuft. The anal papillae have rounded ends, the upper pair being about twice th length of the anal segment, the lower about two-thirds as long as the upper The anal segment has a slight ventral beard and a plume of simple hairs laterally on the posterior edge of the chitinous saddle.

*The number is variable even on the two sides of the same larva; one specimen ha three on one side and seven on the other.—F. W. E.

(C250) Wt. P8/91. 1,000. 5.16. B.&F. Gp. 11/1.

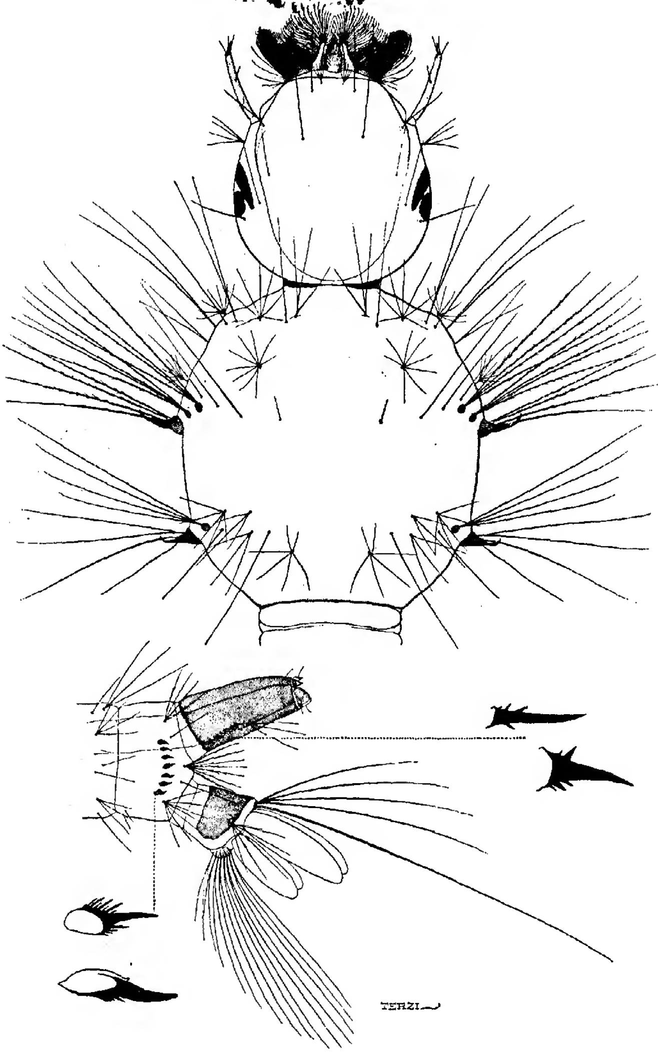

Fig. 1. *Stegomyia metallica*, Edw.

Pupa.—There does not appear to be any distinctive feature about the pupa.

Breeding place.—The larvae were found in a hollow in a tree at Accra (fig. 2). The water in which they were living was clear, but of a dark brown colour. A few specimens of *Culiciomyia nebulosa* and two of *Stegomyia unilineata* were also bred out from the larvae found in this tree.

Fig. 2. A tree in a hollow of which were found larvae of *Stegomyia metallica*, *S. unilineata* and *Culiciomyia nebulosa.*

This particular strain of *S. metallica* was maintained in the laboratory and is understood to be still flourishing now, seven months since the original larvae were obtained. The mosquitos were kept in glass jars and were fed on honey and blood. In this way generation after generation of larvae was bred without difficulty, and up to the present no sensible effects have been observed as a result of this close inbreeding. When isolated in single pairs, however, *S. metallica* did not breed readily.

The females under these conditions fed on blood reluctantly and did not deposit their eggs either frequently or regularly. In one experiment, for example, a newly hatched female isolated in this way took her first meal of blood on the evening of the eighth day, but did not lay any eggs until the twenty-second day. In this respect *S. metallica* differs notably from *S. fasciata*. When kept together in considerable numbers the mosquitos bred freely, and so far as laboratory experience goes, it seemed immaterial to the larvae whether they were reared in a highly nitrogenous, dark brown medium, such as that in which the original larvae were found, or in a comparatively clear one of tap water with a layer of sand at the bottom. The larvae were observed to remain submerged for long periods and were frequently seen to bury themselves completely in the flocculent deposit which collected at the foot of some of the jars. In this they appeared to obtain assistance from the ventral thoracic spines, both in maintaining their position and in penetrating the deposit. The life-cycle of *S. metallica* in one experiment was as follows:—Egg, 7 days; larval stage, 10 days; and pupal stage, 3 days.

Stegomyia luteocephala, Newst. (fig. 3).

The larva is dark in colour and closely resembles that of *S. fasciata*, the thorax exhibiting hook-like spines of a similar size. The head is dark, the antennae are short, having a single hair in place of a hair-tuft, and the midfrontal hairs are represented

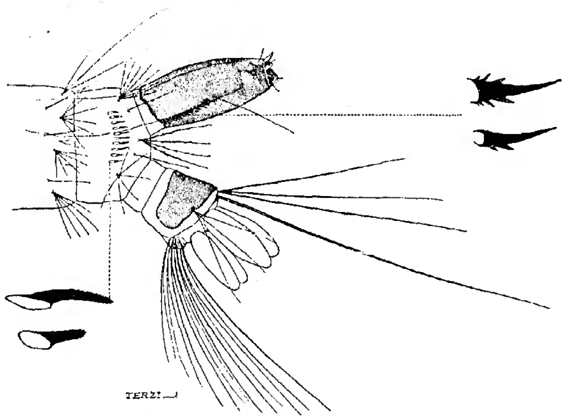

Fig. 3. *Stegomyia luteocephala*, Newst.

by single bristles. The thorax and abdomen bear stellate hairs which are simple in character and not so numerous as those upon *S. metallica*. The comb is formed of 7–10 simple spines, which are longer and narrower than those of *S. metallica*. The siphonal and subsiphonal plumes are composed of simple hairs. The length of the siphon is more than twice the diameter of its base (43 units to 18); the spines of the pecten are 12–15 in number and are placed slightly diagonally, as in *S. metallica*. In the place of the usual hair-tuft a single long stout hair is found; the position of

this hair is well beyond the middle of the siphon. The papillae are longer than the anal segment and have rounded ends; the dorsal pair not much longer than the ventral. As in *S. metallica*, there is a hair-tuft at the lateral edge of the chitinous plate of the anal segment.

S. luteocephala comes close to *S. fasciata* in Edwards' key (Bull. Ent. Res. iii, p. 376): ' Siphon more than twice as long as broad; . . . comb scales 8–9 "; but the hair-tuft is replaced by a single stout hair, and the comb scales are simple.

Pupa.—None was examined.

Breeding place.—The larvae were found in the sagging gutters of two bungalows at Accra. The water in which they were living was slightly turbid and contained a layer of decaying vegetable matter.

Ochlerotatus irritans, Theo. (fig. 4).

The larvae are light in colour. The head is of moderate size, with rather stout antennae, which carry a tuft of simple hairs towards their outer sides; no constriction is seen at the insertion of this hair-tuft in the middle of the antennae. The median frontal hairs are multiple and are slightly pubescent at their bases. The anterior thoracic hairs are poorly developed. The comb is formed of about 50 scales arranged in a triangular patch. The subsiphonal plume consists of hairs which are scantily plumose, while the hairs of the siphonal and anal plumes appear to be simple. The

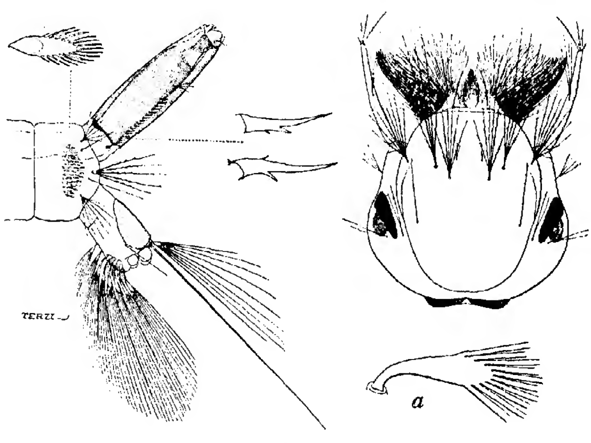

Fig. 4. *Ochlerotatus irritans*, Theo.

length of the siphon is three and a half times the diameter of its base; the pecten, extending to half the length of the siphon, comprises 15–18 spines, and beyond the spines occurs a tuft of three or four hairs. The anal segment is feebly chitinised, while the anal papillae are so short as to appear like projecting knobs.

O. irritans comes near to *O. marshalli* in Edwards' key (Bull. Ent. Res. iii, p. 376) " Median tufts on head each composed of 6–8 hairs, pecten with 12–18 teeth. . . . Hair tuft normal, branched, situated in middle of siphon." Judging from Wesché's

description of the larva of *O. marshalli* (Bull. Ent. Res. i, p. 30) it appears to resemble the larva of *O. irritans* closely. The distinguishing points between the two seem to be that the latter has a siphon which is in length three and a half times the diameter of its base, the siphon of the larva of *O. marshalli* being " quite four times as long as its base," according to Wesché. The tuft on the siphon of *O. irritans* is composed of three or four hairs, while " there are plumes of six simple hairs above the spines on each side " in *O. marshalli*. The anal papillae of *O. irritans* are very poorly developed, those of *O. marshalli* as shown in Wesché's illustration are well developed, with pointed ends.

Pupa.—None was examined.

Breeding place.—The larvae were found in small pools near the lagoon at Accra. The water in these pools is as a rule brackish, and in one sample in which *O. irritans* was flourishing an analysis showed that the chlorine amounted to 1,400 parts per 100,000 (2·2 per cent. salt).

Ochlerotatus sudanensis, Theo. (fig. 5).

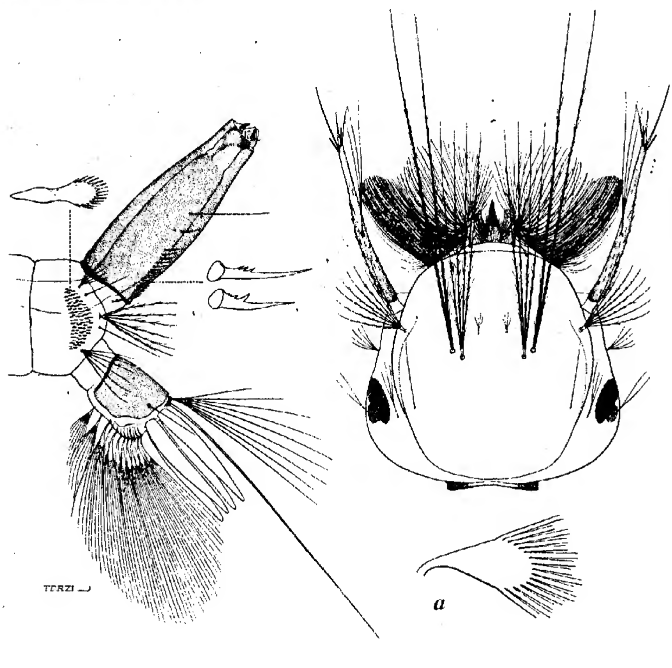

Fig. 5. *Ochlerotatus sudanensis*, Theo.

The larvae in life are grey in colour with a dark siphon, and the head pale. The antennae are well developed and are covered with spicules; the hair-tuft composed of simple hairs is situated before the middle of the antenna. The median frontal hairs are subplumose, the outer pair having two and the inner pair 3–4 branches.

The comb is formed of many scales, 60–70, arranged in a triangle. The siphonal and anal plumes are composed of simple hairs, the subsiphonal of subplumose hairs. The length of the siphon is three times the diameter of its base; there are about 15 spines in the pecten, some of which are detached outwardly, extending beyond the middle of the siphon; a single hair takes the place of the usual tuft. The anal segment is almost as broad as it is long; the hairs on the dorsum are collected into strong tufts, and the ventral beard is well developed, extending over nearly the whole length of the ventral surface, its tufts having a very unusual structure. The papillae are almost twice the length of the anal segment.

O. sudanensis may be distinguished from larvae having "Median tufts on head each composed of three hairs" in Edwards' key (Bull. Ent. Res. iii, p. 376) by the fact that its pecten has about 15 teeth.

Pupa.—This has two small dark spots on the margin of each of the anal plates.

Breeding place.—The larvae were found along the sides of the stream at Sunyani in small holes made by the youthful natives in their search for crabs. The water contained in the holes is always opaque, holding much suspended matter. Larvae of *Anopheles costalis*, *Culex insignis* and *Uranotaenia annulata* were also obtained from these crab holes.

Culex pruina, Theo. (fig. 6).*

The larva in life is light-coloured; is possessed of a siphon swollen in the middle, with its distal third much darker than the proximal two-thirds; and bears some resemblance to the larva of *C. duttoni*, being however of smaller size.

The head is of moderate size and is not so wide as the thorax. The antennae are covered with spicules, the hair-tufts, apparently consisting of branched hairs, are inserted at three-fifths of the length of the antennae. The frontal hairs are all plumose. The comb is formed of 35–40 scales arranged in a triangular patch. The hairs of the siphonal and subsiphonal plumes are plumose, those of the anal plume are simple. The siphon is four times the length of its basal diameter, tapering towards the tip; its distal third is more strongly chitinised than the proximal portion, and its pecten of about 20 spines extends nearly to the middle of its length. On the ventral aspect are at least six pairs of strong hair-tufts and numerous spicules are scattered over this surface between those hair-tufts. The anal segment is about as broad as it is long, and in addition to the usual hairs, has a plume of simple hairs laterally.

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*The adults which Dr. Ingram sent as having been reared from this remarkable larva were *C. pruina*, but the larvae are totally different from those attributed to that species by Dr. W. M. Graham and described by Wesché under the name of *C. pallidothoracis*, Theo. (Bull. Ent. Res. i, p. 36). Dr. Ingram also obtained specimens of this latter form (see fig. 7), which he associated with adults of *C. guiarti*, Bl., though this larva is different from that assigned to *C. guiarti* by Graham. It remains for future investigators to decide which of these two is the true larva of *C. pruina*.—F. W. E.

This larva seemingly should be grouped with that of *C. duttoni* in Edwards' key (Bull. Ent. Res. iii, p. 379). It may be distinguished from the larva of *C. duttoni* by its possessing marked tufts of hairs on the siphon in place of long solitary hairs, and by the number of teeth in the pecten.

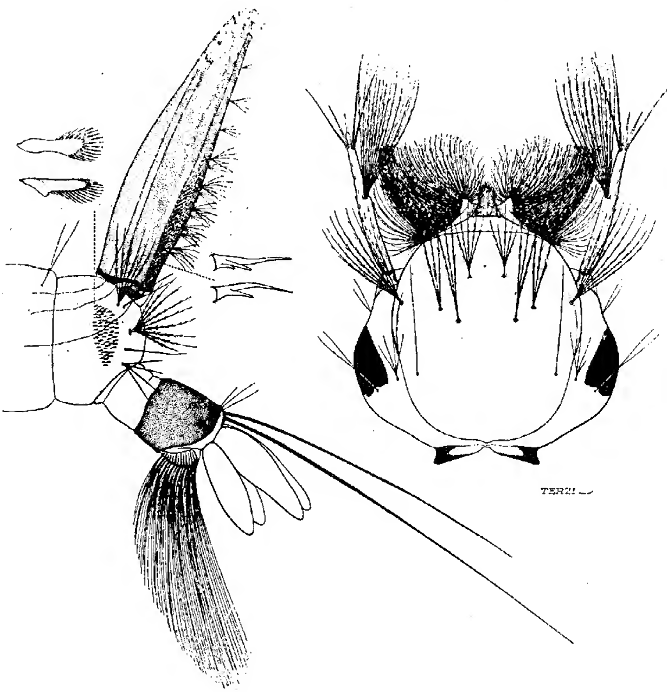

Fig. 6. *Culex pruina*, Theo.

Pupa.—There does not appear to be any distinctive feature about the pupa when examined with a low magnification (60 diameters).

Breeding place.—The larvae, together with those of *Eretmopodites inornatus*, were found in water of a dark brown colour containing decaying leaves and vegetable matter, filling a hollow in the concrete foundation for the erection of a pump.

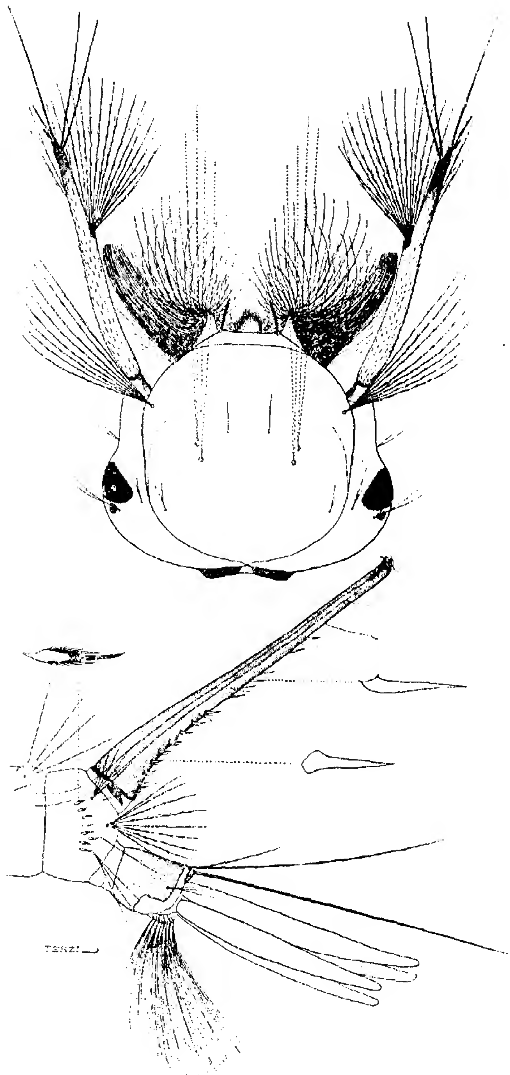

Fig. 7. *Culex* sp. ?—attributed by Dr. W. M. Graham to *Culex pruina*, Theo.

Culex insignis, Carter (fig. 8).

Living larva grey in colour, with very dark hairs on the anal segment. The head is large; the antennae dark and covered with spicules; the hair-tuft, which is prominent and consists of plumose hairs, is inserted at three-quarters of the length of the antenna. The palp is seen to be large when the larva is viewed from the side and the brush is

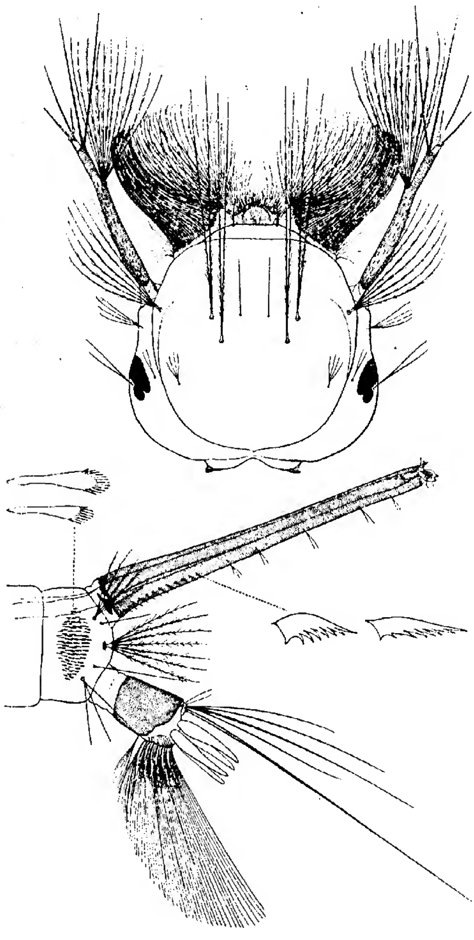

Fig. 8. *Culex insignis*, Carter.

well developed. The median frontal hairs consist of double hairs which are plumose. The anterior thoracic hairs are single and long. The comb is composed of about 70 scales arranged in a triangular patch. The subsiphonal plume is formed of plumose hairs, the siphonal of subplumose hairs, and the anal plume appears to consist of

simple hairs. The siphon is long and narrow, eight or nine times the length of its basal diameter, the pecten extending to a quarter of the length of the siphon, and beyond it are four or five ventral tufts composed of simple hairs. There are 12–15 teeth in the pecten. The anal segment is a little less than twice as long as it is broad, the papillae being sharply pointed, and slightly shorter than the segment. Two of the hairs on the dorsal end of this segment appear to be longer than the siphon.

This larva apparently comes near those of *C. invidiosus* and *C. decens* in Edwards' key (Bull. Ent. Res. iii, pp. 380–381) " Comb of eighth segment with about 40 teeth in a triangular patch. . . . Pecten with 12–15 teeth, antennal tuft at about three-quarters; siphon 8 × 1." It may be distinguished by its dark antennae and by the dark hairs on the anal segment. In life its colour should help in the differentiation, as the larvae of *C. invidiosus* and *C. decens* are usually green in colour.

Pupa.—The pupa seemingly has no distinguishing characteristic.

Breeding place.—The larvae were found in holes excavated by the native children in search of crabs; the water contained in the holes held much matter in suspension.

Culex ingrami, Edw. (fig. 9).

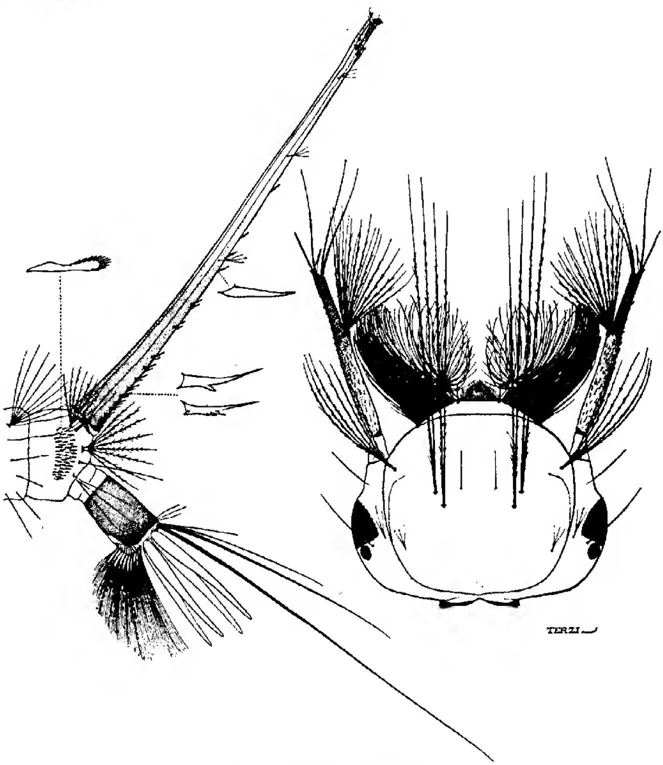

Fig 9. *Culex ingrami*, Edw.

The larvae in life are of a light green colour.

The head is large, being nearly as wide as the thorax. The antennae have the distal third darkened and are covered with spicules, the tufts being placed at two-thirds of the length of the antennae and formed of plumose hairs. The brushes are large, and the mid-frontal hairs are double and plumose. The comb consists of about 50 scales arranged in a triangular patch. The hairs of the subsiphonal and siphonal plumes are plumose, the hairs of the anal plume simple. The siphon is long and narrow, 14 times the length of its diameter at the base and about three-quarters of the length of the abdomen. The pecten is formed of about 12 paired and barbed spines, the last two being more widely separated; beyond these true pecten spines, which extend to about one-third of the length of the siphon, are three or four widely separated spines on the mid-ventral line, and in addition to these there is a group of five or six simple spines lying just below the apex and more closely appressed to the siphon. There are minute hair-tufts of simple hairs inserted between the more widely separated distal spines. The pointed anal papillae are not quite twice as long as the anal segment.

This larva may be distinguished from the other *Culex* larvae in Edwards' key (Bull. Ent. Res. iii, pp. 380–381) which have the "Combs of the eighth segment with about 40 teeth in a triangular patch" by the formation of the pecten and by the length of the siphon, 14×1.

Pupa.—The pupa does not appear to have distinctive features.

Breeding place.—The larvae were found in deep pools of clear water in the thick forest.

Culex consimilis, Newst.

The larva in life is of a brilliant green colour.

The head is large and the abdomen well developed. The hair-tuft is formed of simple hairs and is inserted at or just before the middle of the antenna. The thorax and abdomen have the usual plumes. The comb is formed of six teeth arranged in an irregular line, there being a simple hair at either end of this line of spines. The hairs of the subsiphonal plume are plumose, those of the siphonal pubescent. The length of the siphon is ten times the diameter of its base and is less than half the length of the abdomen (147 units to 356, average of six measurements). The pecten consists of six feebly developed spines, which increase in size distally, the last being detached from the others.

Apparently there is little if any difference between this larva and that of *C. annulioris* in Edwards' Key (Bull. Ent. Res. iii, p. 381).

Pupa.—The respiratory tubes have large apertures which are directed anteriorly, the tubes being placed nearly parallel one with the other.

Breeding place.—The larvae were found in masses of filmy algae in clear water.

Eumelanomyia inconspicuosa, Theo. (fig. 10).

The larva in life is very dark in colour.

The head is dark and large being nearly as wide as the thorax. The antennae are well developed, with a tuft of subplumose hairs situated at about the middle (described from a single specimen). The midfrontal hairs are single and subplumose at their

bases. The anterior thoracic plumes consist of simple hairs, the posterior thoracic and abdominal plumes of plumose hairs. The comb is composed of about 50 scales arranged in a triangular patch. The hairs forming the subsiphonal and siphonal plumes are plumose. The siphon is narrow and long, its length being ten times the diameter of its base, and the pecten of a dozen spines extends for one-fifth of its length. Beyond the pecten are slender tufts of simple hairs, two or three in number. The anal segment is nearly twice as long as it is wide, has a moderate-sized ventral beard and long hairs, as long as the siphon, on the dorsal end. The dorsal pair of anal papillae is pointed and twice as long as the anal segment (ventral pair missing).

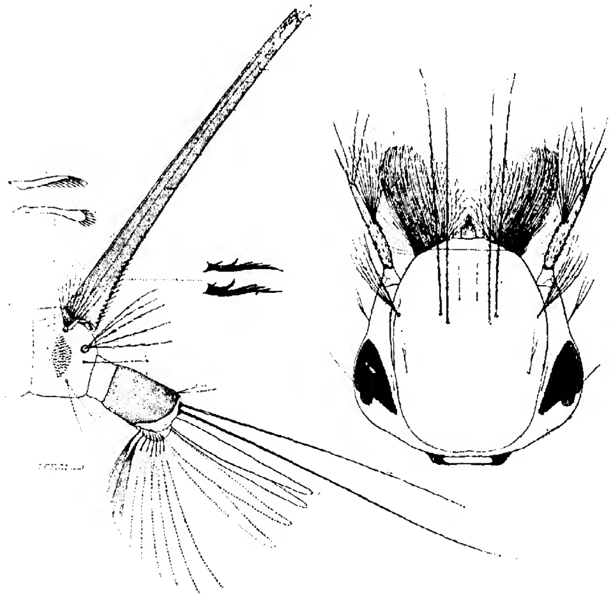

Fig. 10. *Eumelanomyia inconspicuosa*, Theo.

Apparently this larva should be grouped with the *Culex* and *Culiciomyia* larvae in Edwards' key to the genera (Bull. Ent. Res. iii, p. 373): "Siphon usually elongated, its hair-tufts numerous." It may be distinguished from *Culex* larvae which have "Combs of the eighth segment with about 40 teeth" and have "siphons longer than 4 × 1, with pecten of 12–15 teeth" (*op. cit.*, pp. 380–381) by the fact that its mid-frontal hairs are single and stout.

Pupa.—The pupa is very dark in colour, but does not appear to be possessed of distinctive features.

Breeding place.—The larvae were found, together with about a dozen pupae of the same species, in clear water in the burnt-out hollow of a fallen tree in a clearing in the forest.

Mimomyia hispida, Theo. (figs. 11, 12).

The larvae are grey in colour in life, and while resembling the larvae of *M. mimomyiaformis* in configuration, are of a much lighter colour.

The head is large, the antennae having a similar peculiar outwardly directed appendage to that possessed by the larva of *M. mimomyiaformis*; this portion is much lighter in colour than the basal portion and the spicules which cover the base are absent. Two long bristles occur at the junction of the apical with the basal part.

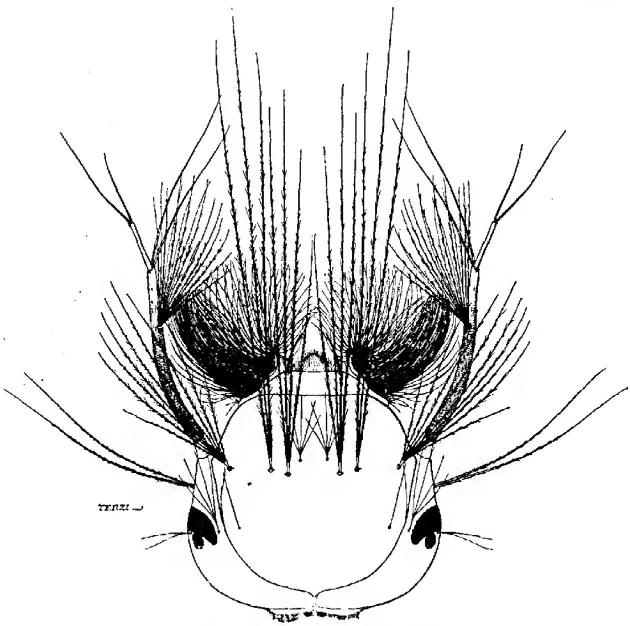

Fig. 11. *Mimomyia hispida*, Theo.

The hair-tuft is situated at about three-fifths of the length of the basal portion of the antenna and is formed of plumose hairs. All the frontal hairs are markedly plumose and there is a bifurcated subplumose hair of considerable size projecting laterally from the head in front of the eye. The palp is large. The long thoracic and abdominal hairs are strongly plumose. The comb is formed of two rows of spines in arched lines, the posterior row consisting of 5–7 large, the anterior of about twenty small spines. The subsiphonal plume is composed of plumose hairs, the hairs of the siphonal and the anal plumes being pubescent. There are many stellate hairs on the abdominal segments. The siphon is six times the length of its diameter at the base, there being three or four feebly developed spines in a horizontal row at its base ventrally and a strong tuft of simple hairs inserted well before the middle. The anal segment is longer dorsally than ventrally and its posterior edge is markedly spinose. The dorsal hairs are collected into strong tufts, while the ventral beard is feebly developed, and there is laterally a long subplumose hair. The anal papillae are about as long as the anal segment.

This larva may be distinguished from the other known larvae belonging to small species of this genus by its double row of spines in the comb (Bull. Ent. Res. iii p. 383).

Pupa.—The pupae of this species do not appear to have the outer third of the respiratory tubes light-coloured (Bull. Ent. Res. iii, p. 384), but only the tips.

Breeding place.—The larvae were found in marshy ground along the edge of the stream at Sunyani, together with the larvae of *M. plumosa* and those of *Uranotaenia alboabdominalis.*

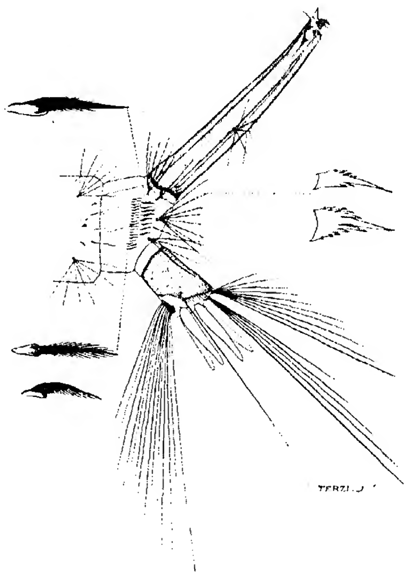

Fig. 12. *Mimomyia hispida*, Theo.

Uranotaenia annulata, Theo. (fig. 13).*

The larva in life measures about 6 mm. being nearly twice as long as the larva of *U. alboabdominalis*. It is of a light grey colour with very dark head and siphon.

*In my paper on African Mosquito Larvae (Bull. Ent. Res. iii, p. 378) I briefly noted a larva which had been received as that of *Stegomyia sugens* or *Uranotaenia nigripes*, and appeared peculiar in having a lateral chitinous plate in addition to the comb on the eighth segment. Mr. Knab shortly afterwards wrote suggesting that this larva might be a *Uranotaenia*, as the possession of a chitinous plate with the comb at the edge was one of the characters of the genus, a fact of which I was not then aware. Dr. Ingram's interesting discovery of the larva of *U. annulata* proves that the Sierra Leone larva must indeed be that of *U. nigripes*, as the two are very similar and agree in having rounded heads and slender frontal hairs. The chief points of difference between *U. nigripes* and *U. annulata* are as follows: the two anterior pairs of frontal hairs are placed far forward, the outer three branched, the inner simple and much closer together than in *U. annulata*; the comb-teeth are about 14 in number and sharply pointed; the siphon is narrower towards the tip; and the anal papillae are nearly three times the length of the anal segment.

It is interesting to note that the group *Pseudoficalbia*, to which both these species belong, can apparently be defined on the characters of the larval head as well as on the scale characters of the adults.—F. W. Edwards.

The head is small, rather broad and rounded (for a *Uranotaenia*) and dark in colour. The antennae are small and stunted, without any visible hair-tuft or hair. The eyes seem to be set further forward on the head than is the case in the majority of larvae. The mid-frontal hairs are represented by single slender bristles, quite unlike the stout spines found in typical species of *Uranotaenia.* The anterior thoracic hairs are numerous but short, the mid and posterior thoracic plumes being formed of plumose hairs, and the long hairs on the anterior abdominal segments are subplumose. There are numerous stellate hairs on the sternum and venter, but the stellate hairs which are so marked a feature upon the dorsum of the abdominal segments of the other two

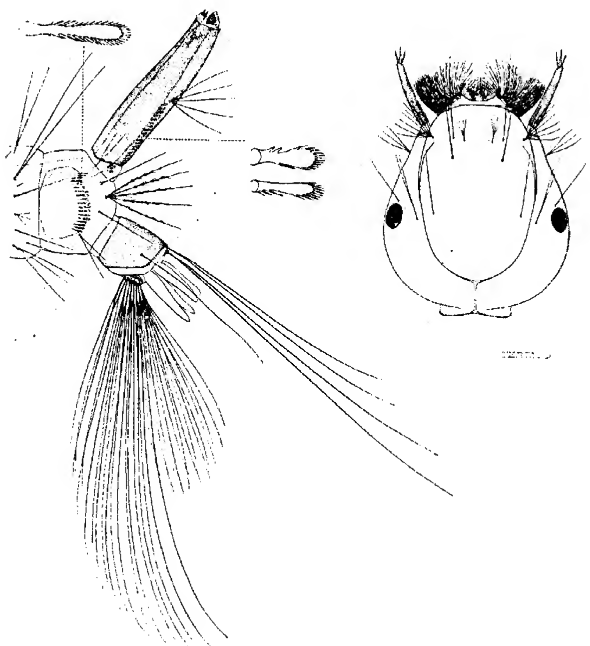

Fig. 13. *Uranotaenia annulata*, Theo.

known larvae of this genus are not visible. The comb consists of an arched line of scales, about 15–18 in number, the convexity of the arch being posterior; the scales are very regularly placed and are of about equal size. The chitinous plate on the edge of which the comb scales are set is large, but feebly developed. The subsiphonal plume is composed of plumose hairs, the siphonal and anal plumes being poorly developed and apparently consisting of simple hairs. The siphon is about four times as long as the diameter of its base; the pecten, extending for about half the length of the siphon, is formed of 18 to 20 blunt-ended and fringed scales, which are similar to those of the comb, very regular and all of equal size; beyond the pecten is a hair-tuft of five hairs. The anal segment is longer than it is wide, with long dorsal hairs

and a distinct ventral beard, the hairs composing the tufts of which are few in number; a long single hair is present laterally and the posterior edge shows a row of slender spicules. The anal papillae are equal in length to the anal segment.

This larva may be readily distinguished from the two other known larvae of the genus by its large size, by the shape of the head and the slender frontal hairs, and by the number of scales (the other two have spines not scales on the eighth segment) in the comb, which number about twenty.

Pupa.—None was collected.

Breeding place.—The larvae were found in excavations made by the searchers after crabs along the margins of the stream at Sunyani.

Uranotaenia alboabdominalis, Theo. (fig. 14).

The larva in life measures $3\frac{1}{2}$–4 mm. and is of a light grey colour, whereas the larva of *U. balfouri* is usually dark.

The head is narrow and elongated, and is not so dark as the head of the larva of *U. balfouri*; the eyes in this species also seem to be placed further forward upon the head than is customary. The antennae are light in colour, short, stunted and without hair-tuft or hair. The mid-frontal hairs are replaced by single stout, spine-like and somewhat flattened bristles; in front of these bristles are two stellate hairs upon the face. In addition to the usual long plumes on the thorax and abdominal segments,

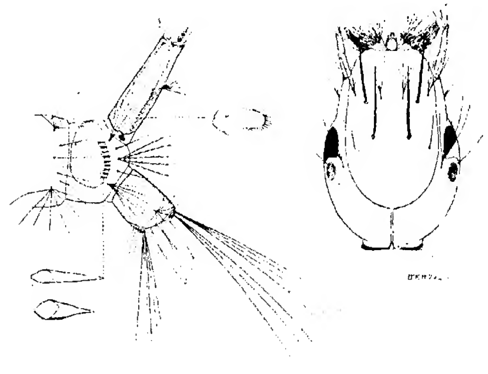

Fig. 14. *Uranotaenia alboabdominalis*, Theo.

there are numerous stellate hairs, which are most marked upon the abdomen. The comb is formed of 8–9 spines, set in a curved line having its convexity posteriorly directed; these spines are very uniform in size, and are set on the posterior edge of the conspicuous lateral chitinous plate. The subsiphonal plume is composed of sub-plumose hairs, the siphonal and anal plumes apparently of simple hairs. In addition to the plumes on the eighth segment, there are one or two stout single hairs and a single stellate hair-tuft. The siphon is in length about $3\frac{1}{2}$ times the diameter of its

base; the pecten, which appears to be formed of 12–15 truncated scales when looked at from the side, extends to just beyond the middle of the siphon. The scales of the pecten are so regularly arranged as to give the impression of a palisade and are followed by a pediculate tuft of simple hairs. The siphon measures a quarter of the length of the abdomen and its valves are large. The anal segment is longer than it is wide (18 units to 12) and has a distinct beard and tufts of hairs on the dorsum, there being also two tufts of stellate hairs laterally; the posterior edge seems to be less conspicuously fringed with spicules than is the case in the larva of *U. balfouri*.

This larva appears to resemble that of *U. balfouri* closely (in its natural conditions it should, however, be readily distinguished by its lighter general colour and pale-coloured head), but the spines of the comb are more numerous and more uniform in size. In *U. balfouri* these spines rarely exceed six in number, and are more widely separated, one spine being usually much larger than the others.

Pupa.—The pupa shows the same peculiarly formed plates as are seen in that of *U. balfouri*, described by Wesché (Bull. Ent. Res. i, p. 50) as knife-like.

Breeding place.—The larvae were found, together with those of *Mimomyia plumosa* and *M. hispida*, in marshy ground along the banks of the Sunyani stream.

We have to express our indebtedness to Mr. F. W. Edwards, of the British Museum, for kindly identifying the mosquitos bred from these larvae; he has also been good enough to suggest certain emendations in the descriptions here given, and has supervised the preparation of the admirable drawings by Mr. A. J. E. Terzi.

A SUMMARY OF AN ENTOMOLOGICAL SURVEY OF KADUNA DISTRICT, NORTHERN NIGERIA.

By J. E. L. Johnston, M.B., B.S. (Lond.), D.T.M. & H. (Camb.),

West African Medical Staff.

Kaduna, the future capital of Nigeria, is situated in the Northern Provinces, on the River Kaduna, at an elevation of roughly 2,200 feet. The present Kaduna is a small station (Kaduna Bridge) south of the river, but the capital now in the process of construction is some two or three miles to the north, near the small native town of Doka.

Being instructed to make an Entomological Survey of the district, with especial reference to *Glossina* and the resulting presence of trypanosomes in cattle, I left Lagos on 30th July 1914, reaching Kaduna Bridge on 1st August.

Kaduna Bridge.

I decided to remain some days at Kaduna Bridge, examining the place and its immediate neighbourhood, then to move to the site of the new Kaduna (the native town of Doka) on the other side of the river, and after a few days there to start on a tour in a circle round Kaduna.

It became immediately obvious that there were very few flies to be obtained in either the old or the new Kaduna. It is probable that this was largely due to the unusual weather conditions. Table I. shows the rainfall for 1913, and for 1914 up to the end of August.

Table I.

	1913.	1914.
January	Nil	Nil
February	·11	·26
March	Nil	·26
April	2·16	·4
May	5·81	3·27
June	5·22	6·77
July	11·81	1·84
August	11·53	7·59
September	13·59	
October	1·71	
November	Nil	
December	Nil	

From this it will be seen that in July and August 1914 there were only 1·84″ and 7·59″ as compared with 11·81″ and 11·53″ for the same months of 1913, and for the first eight months of the year there were only 20·39″ in 1914 as compared with 36·64″

in 1913. There was also a marked contrast between the conditions during my first stay at Kaduna and my second, a few weeks later, after there had been some heavy rains.

I could obtain no history of any illness amongst the many horses in Kaduna, and tsetse-flies were practically unknown.

Birnawa.

I was told that tsetses abounded along a small stream half-way between Kaduna Bridge and the village of Birnawa, but although I visited this stream and another flowing close to the village, and the thick "kurmi," or bush, on the banks of each on three successive days, I found none at all. The streams were almost dry, and consisted chiefly of a chain of pools, from which I obtained numerous mosquito larvae, all of which proved to be *Culiciomyia nebulosa.*

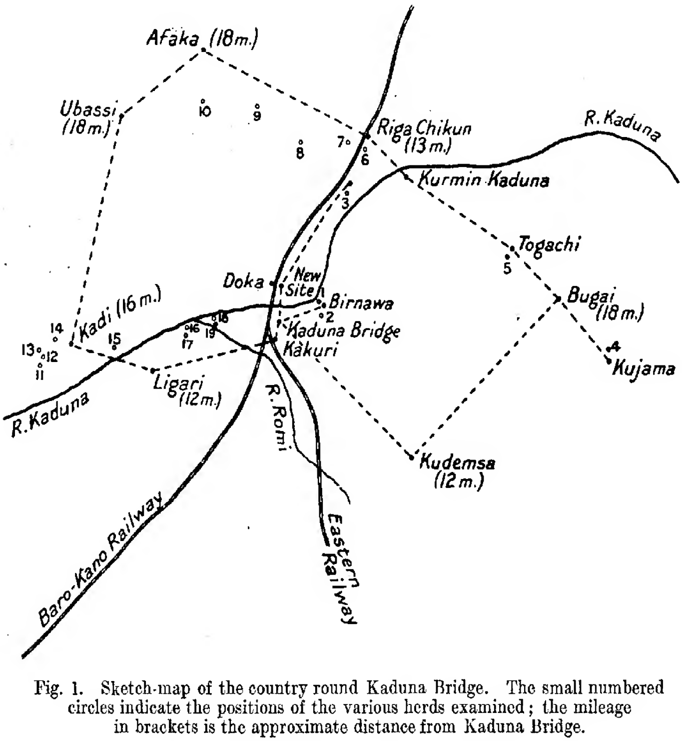

Fig. 1. Sketch-map of the country round Kaduna Bridge. The small numbered circles indicate the positions of the various herds examined; the mileage in brackets is the approximate distance from Kaduna Bridge.

There were two small herds of cattle near Birnawa (see fig. 1, nos. 1 and 2) and I took a few blood films from each herd. The herdsmen told me that flies that troubled the cattle had been plentiful in the kurmi six weeks earlier (*i.e.*, during the wet weather in June), but that there were none now, and I could obtain no history of any sickness. However, two of the first herd showed trypanosomes, and one of the second piroplasmata

I experienced here, and at most other places, some difficulty in getting blood films. The cattle for the most part belong to Fulanis, who wander about, stopping at one place perhaps one, two, or three months, and then moving on to a fresh part of the country. The Fulanis seemed rather suspicious, and the news of my coming spread rapidly, with the result that I frequently rode miles to see some cattle only to find that they had been taken further into the bush and deliberately hidden. As each cow had to be caught and thrown, the natives naturally disliked the trouble, and it was difficult to obtain many films from any one herd. A further difficulty was later met with in heavy rain, any water on a film spoiling it for minute parasites such as piroplasmata.

I collected a large number of ticks at Birnawa and at other places to which I subsequently went.

The New Kaduna.

After spending a few days examining the neighbourhood of Kaduna, and obtaining a few films from cattle brought into the town for slaughter, I moved on 6th August to the site of the new capital, some three miles north of Kaduna Bridge.

Near the village of Kawo, some eight miles from the new site, I found some cattle from which I got a few films. This herd (no. 3) had lived in the neighbourhood for years without any sickness occurring, but one of the four films showed trypanosomes. The country around Kawo consists of fairly open thin bush, well raised above the River Kaduna, and not containing the many small streams that occur in most of the other districts I visited.

Kakuri.

On 10th August I went to Kakuri, but I found nothing of interest, except many mosquito larvae in various pools in the bed of the River Remi, about two miles south of Kakuri, all of which proved, on hatching out, to be *Stegomyia sugens*.

Near Kakuri itself, and especially close to the River Romi, the kurmi is very dense, and should be suitable for *Glossina* to breed freely, should they be introduced. This does not hold good for an area further south-west, between the River Romi and River Kaduna, to which I shall refer later.

Kudemsa.

On 13th August I moved out to Kudemsa, a pagan village about twelve miles east of Kaduna Bridge. The country around is of the usual type of low thin bush, but like most of the villages in this district there is a stream close by, with dense kurmi, and the village is more or less surrounded by a wall and a deep ditch, providing an immense breeding-ground for mosquitos after any rain.

There are no cattle, but a few horses kept here are apparently healthy. *Haematopota* were numerous by the stream, and *Culicoides* were extremely troublesome in the rest-house.

Bugai.

On 15th August I went to Bugai, roughly 18 miles north-west of Kaduna Bridge.

Hearing that there were some cattle near Kujama, some four or five miles to the south-east of Bugai, I visited this place on the 15th and 16th (herd 4). One sheep

and two cows were sick, and I took films from these and other cattle, but with negative results. I could get no history of any serious cattle-disease in the neighbourhood.

Bugai is a small village below a high hill of solid rock, out of which a small spring emerges some half-way up. There is a stream close by, with dense kurmi. For many miles round the bush is very low and sparse, interspersed with high rocky hills and many small streams, which after heavy rains might be suitable for *Glossina*, though I failed to see or to obtain history of any. Bugai is a purely pagan village, and keeps neither cattle nor horses.

Togachi.

On the 17th I moved to Kurmin Kaduna, on the banks of the River Kaduna. Near the village of Togachi I visited a herd of cattle (herd 5) that had been there for two or three months, originally coming from far south. There was a history of a very fatal sickness occurring during the dry weather only, consisting apparently of a swelling of the nose and face, the cattle being described by the natives as " sick in the nose." Most of the cattle showed signs of the treatment, which consisted in cutting and removing a large amount of skin and subcutaneous tissues over the nasal bones. This herd was quite savage, and I could only obtain six films, of which one was infected with trypanosomes.

Kurmin Kaduna.

The country on the way from Bugai to Kurmin Kaduna is similar to that between Kudemsa and Bugai—many small rocky hills, and hence many small, nearly dried-up streams—but asone approaches Kurmin Kaduna and the River Kaduna the country becomes flatter and the bush thicker.

I saw no tsetse, although stopping with the horses (which attract tsetse readily) for about two hours on the bank of the river. There were no horses or cattle at Kurmin Kaduna ; I heard that two horses had died there last year.

Riga Chikun.

On the way to Riga Chikun one passes through a good deal of thicker bush than is usual, and some low swampy ground, and crosses two small streams, tributaries of the River Kaduna. The second of these, the River Kworo, running about a mile from the town, is of particular interest in that Dr. Foy reports that in September 1913 *Glossina* (both *palpalis* and *tachinoides*) were to be found there in abundance. At that time the Kworo was some four feet deep ; when I visited it the average depth was barely six inches, and although I spent some hours on its banks, on a day very favourable for flies, I found no tsetse.

The Sariki (or Headman) of the town told me that some cattle that had come from Kano last year had brought infection with them, and that he had lost many of his cattle, but that the disease had died out. It is obvious that though there may have been no *Glossina* when I was there, the conditions may be very favourable for them after a wetter season. Of nineteen cattle examined from two herds (nos. 6 and 7), east and west of the railway line, two showed trypanosomes and three piroplasmata.

Afaka.

Going roughly north-west to Afaka the country is much drier and more open than between Kurmin Kaduna and Riga Chikun. There are no large streams, and the few small ones were all but dry.

I visited three herds of cattle *en route*. One very large herd (no. 8) had been living here, I was told, for several years, without any history of illness, but I found four out of eight cattle examined infected with trypanosomes, possibly through approaching Riga Chikun and the River Kworo in changing the pasturage. The two other herds (nos. 9 and 10), living several miles further from Riga Chikun, were free.

Afaka is surrounded by the customary mud wall and deep ditch, and, as usual, a small stream runs in a curve some half mile from the village. Mosquitos, almost all *Culiciomyia nebulosa*, were very troublesome.

Ubassa.

On 22nd August I moved on to Ubassa, through the same low thin bush met with on the way to Afaka. I crossed three or four nearly dried-up streams *en route*, but although I halted at each, I saw no trace of tsetse.

Ubassa is a small village on a steep hill; the bush immediately along a stream at the foot is fairly thick. There are no cattle, but the Sariki's horses apparently keep well. The Sariki informed me that Fulani herdsmen, on passing through his district, complained that their cattle were bitten by troublesome flies, but native histories are of doubtful value. Sandflies (*Culicoides* sp.) were very troublesome in the rest-house and mosquitos were numerous.

Kadi.

On the 23rd I went to Kadi, a fairly large Mohammedan village, the route lying across several small streams and some deep ravines, the intervening bush being thin.

The Sariki told me that he had had a large herd last year, but that after he brought a bull down from Kane every cow died within a few months. Apparently his grazing ground had been close to the stream Rafin Kurmi. This stream is rather unusual in being clear and swift, and in having exceptionally deep banks shaded by large forest trees, in addition to the usual low thick bush. By this stream I caught some tsetse-flies for the first time in this tour—two *G. palpalis*.

The Sariki now had three small herds, the positions of which are shown on the sketch-map (nos. 11, 12, 13), all in good health and free from trypanosomes, though no less than nine out of twelve examined showed piroplasmata. In another herd a few miles away (no. 14) on the River Kachamari two cows had recently died, and a third, which was sick, showed trypanosomes. Of five others examined from this herd, four showed piroplasmata, but none trypanosomes.

In Kadi itself, mosquitos were very scarce, but *Culicoides* were numerous and troublesome.

On the 25th I moved to Ligari, taking blood films from a herd close to the River Kaduna (no. 15). This herd had been here for four months without sickness, and although I waited with the horses on the bank of the river for two hours, I saw no tsetse; yet out of eight films two showed trypanosomes, and six piroplasmata.

Ligari.

Ligari is an almost deserted and utterly dirty pagan village, placed on a small clearing and surrounded by deep ravine-like ditches, dense bush, and high forest trees. The few inhabitants kept no cattle, horses, or sheep. I caught few biting flies and no mosquitos.

Moving next day to Kakuri, I visited two herds (nos. 16 and 17) near the junction of the River Romi with the Kaduna. They had each been here about two and a half months, herd 16 having previously been further down the River Kaduna, opposite Kadi, while herd 17 had come from Godani, a good distance south. Of eight of the former, one showed trypanosomes and four piroplasmata; of eight of the latter, six had piroplasmata.

Kakuri.

Going to Kakuri one met two streams—the second, the River Romi—each much swollen by recent rains, and hence very difficult to cross. The bush in this neighbourhood is very definitely thicker than in the higher-lying district round Kaduna, Kudemsa, Bugai and Togachi.

From Kakuri I went to two herds (nos. 18 and 19) in the narrow angle made by the junction of the Romi and Kaduna. They had each been here about one month, coming from Serikin Pawa, a few stations south on the railway. Of the first, four out of nineteen showed trypanosomes and four piroplasmata; of the second, one out of nine showed piroplasmata.

Near Kakuri and near the River Romi, the kurmi is extremely thick, but otherwise the rough triangle within the Railway, the Romi and the Kaduna, consists of very thin low bush and is practically unbroken by any streams.

River Kaduna.

I returned to Kaduna Bridge on 27th August, and three days later proceeded to survey the north bank of the Kaduna more thoroughly, for about ten miles above Kaduna Bridge. The whole of this area is intersected by many small streams, and is comparatively low-lying, and many places were at this time marshy and difficult.

The most interesting point was the capture of a *G. tachinoides*. Flies were very prevalent, and I caught over fifty *Haematopota* (of various species) at this time, which suggests either that this tsetse was a stray fly, having possibly come from the railway, or else, if indigenous, that the number of tsetse breeding here is very small.

General Remarks.

During the whole tour, therefore, I only caught three tsetse-flies, one *G. tachinoides* near the new Kaduna, and two *G. palpalis* near Kadi. There can be no doubt however that tsetse do occur elsewhere, especially on the River Kworo near Riga Chikun. After heavy rains the many small streams get much swollen, and tsetse may then readily fly up these streams from the Kaduna, especially the larger streams such as the Kworo or the Romi, retreating again in dry seasons.

Moreover *Stomoxys*, especially *S. nigra* and *S. calcitrans*, abound, and the rôle of these flies is not yet fully known. Dr. J. W. Scott Macfie (Ann. Trop. Med. and Paras. 1913, pp. 359–362) has shown that trypanosomes (*T. nigeriense*) will develop

in the gut of *S. nigra*. On the other hand, *Glossina* seldom travel far from a stream (unless following cattle, *e.g.* down a railway), and it is more than probable that the infected cattle were bitten near one or other of the many streams mentioned. The cattle are every day driven far out into the bush for pasturage, and they are bound in a short time to visit the banks of some stream. Moreover the Fulani cattle-owners are migratory and seldom live at any one spot for more than a few months.

Films were taken from 150 head of cattle in all, and of these 19 (12·6 per cent.) were infected with trypanosomes, while no less than 39 (26 per cent.) showed piroplasmata.

Of the twelve sheep examined one was infected with piroplasmata, but none with trypanosomes.

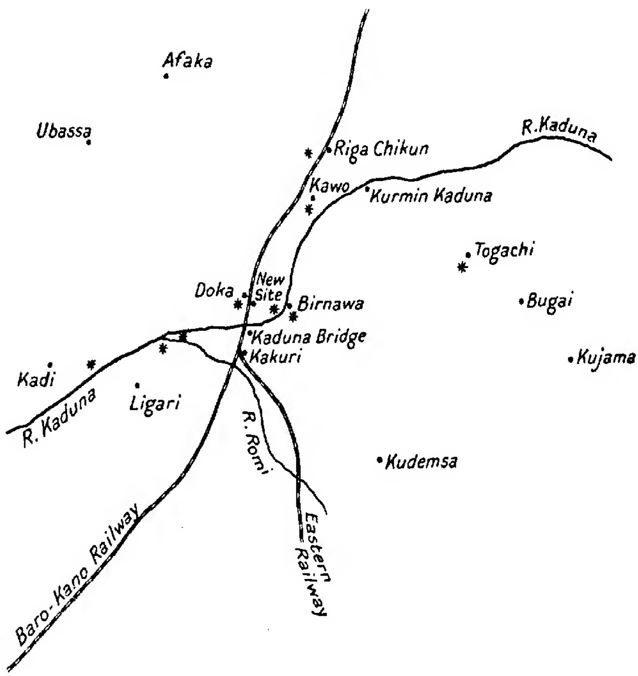

Fig. 2. Sketch-map of the country round Kaduna Bridge. The asterisks indicate the presence of tsetse-flies or of cattle infected with trypanosomes.

The trypanosome causing infection in most cases was of the *T. vivax* type.

The piroplasmata showed great variation in shape and size. Some were large pyriform bodies, often with two chromatin dots, or several minute chromatic granules; some were rings, sometimes extremely minute, sometimes fairly large, showing well-marked chromatin. Occasionally there was a large, more or less confused mass of protoplasm and chromatin, which in some instances could be seen to consist of more

than one parasite. Bacillary forms were common, as were thicker forms intermediate between the bacillary and ring-shaped types. These various types were occasionally to be seen in one film.

A list of the blood-sucking flies and ticks obtained is appended. I saw a fair number of large TABANIDAE which I was unable to catch.

I was unfortunate in losing a large number of mosquitos, chiefly from Kaduna Bridge, owing to the boxes containing them being attacked by ants. It will be seen by reference to the following Table that by far the commonest mosquito was *Culiciomyia nebulosa* (51·85 per cent.), that *Anopheles costalis* and *Culex duttoni* each amounted to 14·19 per cent., and that the remaining 19·7 per cent. was formed by ten different species.

TABLE II.

Showing percentages of Mosquitos caught.

*Culiciomyia nebulosa**	84	= 51·85%
Anopheles costalis	23	= 14·19%
Culex duttoni	23	= 14·19%
Stegomyia fasciata	6	= 3·70%
Culex decens	5	= 3·08%
Stegomyia africana	5	= 3·08%
Culex tigripes	3	= 1·85%
Ochlerotatus cumminsi	3	= 1·85%
Stegomyia simpsoni	3	= 1·85%
Culex fatigans	2	= 1·23%
Mansonioides uniformis	3	= 1·84%
Culex annulioris	1	= ·61%
Stegomyia sugens†	1	= ·61%

*In addition to these 14 specimens were bred.
†56 specimens were bred.

I am very much indebted to the District Officer (Mr. A. C. Francis), the Senior Medical Officer (Dr. H. P. Lobb), and the Assistant Engineer (Mr. J. Sutherland-Brown) for great assistance throughout my tour; to Mr. S. A. Neave, of the Imperial Bureau of Entomology, for kindly identifying the TABANIDAE; to Professor

G. H. F. Nuttall and Mr. C. Warburton for the names of the ticks; and to Mrs. A. Connal, of Yaba, who was good enough to examine a large number of the flies named in the accompanying lists.

The publication of this report has been unavoidably delayed, owing to military operations in West Africa.

A List of the Blood-sucking Flies and Ticks obtained.

DIPTERA.

CULICIDAE.

Anopheles costalis, Lw.—Kaduna Bridge, Doka, Riga Chikun.
Mansonioides uniformis, Theo.—Kudemsa, Kurmin Kaduna, Ubassa.
Stegomyia africana, Theo.—Kaduna Bridge, Afaka, Ubassa.
,, *fasciata*, F.—Kaduna Bridge, Doka, Kudemsa, Riga Chikun.
,, *simpsoni*, Theo.—Kudemsa, Afaka.
,, *sugens*, Wied.—Kakuri.
Ochlerotatus cumminsi, Theo.—Kudemsa, Ubassa.
Culex annulioris, Theo.—Kaduna Bridge.
,, *duttoni*, Theo.—Kaduna Bridge, Doka, Riga Chikun, Ubassa.
,, *fatigans*, Wied.—Kaduna Bridge, Kakuri.
,, *tigripes*, Grp.—Doka, Ubassa.
Culiciomyia nebulosa, Theo.—Kaduna Bridge, Birnawa, Kudemsa, Riga Chikun, Afaka, Ubassa, Kadi.

TABANIDAE.

Haematopota gracilis, Aust.—Doka, Bugai.
,, *lacessens*, Aust.—Kudemsa, Kadi, River Kaduna.
,, *pertinens*, Aust.—Bugai, River Kaduna.
,, *puniens*, Aust.—Doka.
,, *sp.* near *tenuicrus*, Aust.—Bugai.
,, *vittata*, Lw.—Afaka.
,, *sp.*—Kudemsa.
,, ? *sp. nov.*—Kadi, River Kaduna.
Tabanus albipalpus, Wlk.—River Kaduna.
,, *fasciatus*, F.—River Kaduna.
,, *billingtoni*, Newst.—River Kaduna.
,, *secedens*, Walk.—River Kaduna.
,, *socialis*, Walk.—River Kaduna.
,, *taeniola*, P. de B.—River Kaduna.

MUSCIDAE.

Glossina palpalis, R.D.—Kadi.

„ *tachinoides*, Westw.—River Kaduna.

Stomoxys calcitrans, L.—Kaduna Bridge, Kudemsa, Bugai, Ligari, River Kaduna.

„ *nigra*, Macq.—Kaduna Bridge, Doka, Kudemsa, Riga Chikun, Ligari, River Kaduna.

„ *omega*, Newst.—Ligari, River Kaduna.

Philaematomyia sp.—River Kaduna.

HIPPOBOSCIDAE.

Hippobosca maculata, Leach.—Kaduna Bridge, Doka, Kudemsa, Bugai, Kadi, Riga Chikun, Afaka, Ligari, River Kaduna.

ACARI.

IXODIDAE.

Boophilus annulatus, Say.—Kaduna Bridge, Doka, Riga Chikun, Afaka, Kadi.

Haemaphysalis leachi, Aud.—Doka, Afaka.

Amblyomma variegatum, F.—Birnawa, Doka, Togachi, Riga Chikun, Afaka, Kadi.

Hyalomma aegyptium, L.—Doka, Togachi.

THIRD REPORT ON GLOSSINA INVESTIGATIONS IN NYASALAND.

By W. A. Lamborn, M.R.C.S., L.R.C.P.,

Imperial Bureau of Entomology.

I remained in the proclaimed area till 6th August 1915, then returning to the vicinity of Monkey Bay for the purpose of endeavouring to establish artificial breeding places on a large scale.

While in the proclaimed area I took the opportunity of completing my survey of the distribution of *Glossina morsitans*, especially in the neighbourhood of Rifu and Kuti described by Dr. Shircore (Bull. Ent. Res., v, p. 87) as "primary centres 1 and 2," which I had been unable to examine last season before the advent of the rains. As in the case of "centres 3 and 4," at Nyansato and Lingadzi respectively, I have not been able to find that the fly is sufficiently localised, even when the dry season is far advanced, as to render feasible any attempt to control it by prophylactic clearing of the bush. In the Rifu district there is a range of rocky hills and high ground running more or less parallel to the lake, with corresponding modification of the soil, so that a zone of scrub has sprung up, from half a mile to two miles in width, consisting very largely of thorn bush, among which are a few big trees. Towards the north this gradually dwindles, to be replaced by the borassus palms usually growing in the sandy ground along the Lake shore, and towards the south it gradually widens out and becomes continuous with the Kuti bush some five miles distant. Throughout its whole extent the fly was plentiful.

At first sight it was thought that on account of its narrowness this zone might be suitable for attempting measures other than by clearing for the control of the fly, but it was subsequently found that there was inter-communication between the flies in it and in the main area distant from two to five miles across the dambo. Over this intervening space isolated trees and thickets of dwarfed bushes are scattered thickly, the latter usually from 50 to 200 yards apart, and from north to south runs in the dry season a very rough path, in passing along which it has been my constant experience to be assailed by the fly in small numbers. I have found them also at many other points on the dambo, so that there can be no question as to communication between those at Rifu and those in the main area. The lower branches of the bushes, which on the dambo are stunted and low-growing, have been found to afford shelter for small numbers of pupae. Rifu is not, in my opinion, therefore suitable for a control experiment of the nature suggested by Dr. Shircore.

At Kuti there was no greater concentration of the fly, and there was nothing approaching to a break in its distribution right up to Nyansato.

At Rifu, finding pupae both under shelter of dead trees and under cover of rocks, I took the opportunity of collecting some with a view to determining, when both situations are present, whether either is especially favoured. The following are the results:—

Situation.	Date.	New pupae found.	Old pupa cases found.
Under trees ..	17.vii.15	7	180
,, ..	18.vii.15	9	164
,, ..	20.vii.15	8	171
		Total .. 24	515
Under rocks ..	21.vii.15	10	138
,, ..	22.vii.15	2	96
,, ..	23.vii.15	7	118
		Total .. 19	352

The small number of living pupae is to be accounted for by the breeding season being at a minimum during the late dry season, confirmation of which is afforded by laboratory experience.

Mutilla glossinae, Turner.

A large number have now been bred from known pupae. The act of parasitism has already been described in a previous report, and to my account I should add that in most cases, when the pupa attacked has been on the surface of the ground, the female is at particular pains to cover it with soil subsequent to oviposition, collecting earth together with its fore-limbs from various points, after the manner of a *Bembex* closing its burrow, and shovelling it back over the pupa with its hind limbs.

The site for puncture is invariably about midway between the two poles of the pupa. The delicacy with which the operation is effected seems to vary considerably, so that though in some cases the site is readily found on examination with a lens and may be marked by a little shining sticky patch to which a few grains of earth sometimes adhere, in others no sign of it can be detected.

Indisputable evidence has been obtained that this *Mutilla* is a direct parasite, for it has been bred from pupae of known history, i.e., from pupae obtained from captive flies and not subjected to other parasites, and a fact of importance is that the pupa is attacked, especially I believe, in the later stages. As already noted, an undersized female specimen was found on opening a tsetse pupa containing the head and most

of the thorax of a tsetse imago, and further evidence of a like character was obtained more recently by finding, on opening another pupa, a fully fed Mutillid larva of the usual Aculeate type (which has since formed a cocoon) with the harder parts, head, proboscis and femora, of a tsetse imago at one end.

The period of development at which the pupa is parasitised may afford some explanation of the considerable variation in the size of the Mutillids, those which as larvae have had to feed on the imago of a fly so advanced in development as to have tough indigestible parts yielding undersized parasites. Some confirmation of the supposition has been obtained by subjecting *G. brevipalpis* pupae, which are at least three times the size of those of *morsitans*, to a female *Mutilla*. A pupa was seen to be attacked on 2nd July and a male *Mutilla*, a finer specimen than those obtained from *morsitans* pupae, emerged on 27th September. This is the more interesting in that I have not been able to obtain evidence that in the ordinary course of nature this *Mutilla* attacks the pupae of *brevipalpis*, for an examination of 737 empty cases showed that three only had been parasitised, exhibiting the small round holes that seem to indicate the emergence of large Chalcids, and no Mutillid cocoons were found. Moreover, the situation of the breeding grounds in the depths of thick gloomy bush is not propitious to the activities of the Mutillids, which, like most of their kind, exhibit the maximum activity in the hottest, brightest situations.

The greater part of the experimental breeding work has necessarily been carried out by means of pupae found in natural breeding places, for though, thanks to Dr. Hearsey, the Principal Medical Officer, the apparatus left by the Royal Society's Commission was placed at my disposal, I was still unable, from lack of a sufficiency of jars and owing to difficulties incidental to work in a tent, to raise a sufficiency of bred pupae. The results are therefore open to the criticism that fallacy may have crept in owing to the use of pupae of unknown history, but apart from the fact that Mutillids have been seen repeatedly to oviposit in the pupae, the high percentage that have emerged, contrasting with the low figures obtained by an examination of the pupa-cases found, does at all events indicate the probability that the insects have been bred on something approaching a large scale. I am now taking measures to obtain a more ample supply of bred pupae for the purpose of estimating the fecundity of the parasite.

Three large breeding experiments have been conducted. The following table gives details as to the emergence of Mutillids in cases in which parasitism of the pupae was actually seen to be in progress, the pupae being marked and subsequently removed.

Date of parasitism.	Emergence.	Males.	Females.
9–v. –15	20–viii.–15	1	. .
15–v. –15	21–viii.–15	1	. .
19–v. –15	22–viii.–15	. .	1
20–v. –15	20–viii.–15	1	. .
22–v. –15	27–viii.–15	. .	1
27–v. –15	2–ix.–15	. .	1
4–vi.–15	20–viii.–15	1	. .
4–vi.–15	26–ix.–15	. .	1

In the first experiment, from 16th May to 14th June, 20 pupae were subjected to five female Mutillids, and from these three male and five female parasites were bred between the 14th July and 3rd September.

A fresh experiment was commenced on 14th June and finished on 7th July, by which time 250 pupae had been subjected to 20 female Mutillids. Between 24th August and 26th September 36 male and 75 female parasites emerged from these pupae.

A third experiment was commenced on 7th July and terminated on 4th August, by which time 200 pupae had been subjected to 24 Mutillids. As a result, 19 male and 35 female parasites were obtained from 20th August to 6th October.

Up to 6th October, therefore, the 470 pupae subjected to female Mutillids have yielded a total of 173 of the parasites (58 males and 115 females), which gives a percentage of about 36, and a balance of 114 pupae still remains. Some of these may be dead, for they have suffered many vicissitudes, but a few which have been carefully chipped show the *Mutilla* cocoon within, so that the percentage may be considerably higher.

An examination of the 9,285 pupa-cases found between 7th April and 2nd June, from the same locality from which the pupae utilised were taken, shows that 353 had been parasitised, a percentage of rather over 3, and in the course of further work in the same neighbourhood, from 22nd August to the 16th October, 7,731 cases have been obtained, which show parasitism by the Mutillids in 487 instances, or 6·3 per cent. In neither set of figures has the question of hyper-parasites, which are relatively scarce, been taken into consideration.

In connection with the figures quoted, it is perhaps well to emphasise the fact that the material composing the *Mutilla* cocoon is unaffected even by long soaking in water, and is so tough as to be proof, as experiment has shown, against the attack of ants, the insects most likely to destroy it.

The length of time occupied by the *Mutilla* in its development within the tsetse pupa seems to vary so very considerably as to lead one to suspect that emergence must be determined by factors other than developmental ones, possibly climatic changes. In the case of the *Mutilla* bred from a *brevipalpis* pupa development occupied 12 weeks three days, whereas Mutillids are even now coming out from pupae found in mid-May, fully 17 weeks ago.

With the advance of the dry season there has been a remarkable increase in the numbers of *Mutilla glossinae*, in fact of parasites of all kinds, that have emerged from pupae in my possession, so much so that the Mutillids now outnumber the tsetses. Out of 762 new pupae obtained from natural breeding places between 22nd August and 16th October, 97 of the flies, 45 males and 52 females, have so far emerged, as compared with 131 Mutillids, 62 males and 69 females. Surprising figures were obtained with wild pupae, all of which were taken close to a water-hole, which has dried up during the last four months, from breeding places which were all carefully searched before for pupae in May. Under shelter of one particular fallen log in a coppice were found on 24th and 25th August no less than 40 pupae (90 new ones having already been removed from the same place in May), and these pupae with others found thereabouts, amounting in all to 85, were utilised for the purpose of ascertaining the

best method of dealing with captured specimens of *Thyridanthrax abruptus*, a Bombyliid fly parasitic on *G. morsitans*, in the hope of elucidating its life-history. From these pupae, which were set aside after having been kept with a succession of Bombyliids, no less than 41 Mutillids, 19 males and 22 females, have emerged to date (16th October), apart from nine Bombyliids which may or may not be the outcome of the experiment, and only 11 tsetses, five males and six females.

Seeing that the Mutillids are now emerging in such numbers from pupae obtained near Monkey Bay, it is not a little remarkable that only two parasites, one a Mutillid and the other a Bombyliid, have emerged from pupae obtained within the proclaimed area, though in all 368 living pupae were found in various localities within the area. Their comparative rarity there has been confirmed by an examination of the 4,192 cases obtained at the same time, none of which showed evidence of parasitism.

A second Mutillid Parasite.*

Several specimens of an entirely different species of *Mutilla* have recently emerged from pupae found at Monkey Bay many weeks ago, though in two cases only is the precise date available. These pupae were found on 22nd May, and from one of them a male *Mutilla* emerged on 9th October and from the other a female on the following day. The remaining pupae parasitised by this insect were found before 2nd June, and the parasites, four females and four or five males, emerged between 16th August and 9th September.

The males of the new species present a close general similarity to the males of *M. glossinae*, though differing in build, being much slighter; but the females present a totally different abdominal pattern, in addition to being smaller. Their specific difference is shown by the total neglect of the females by the males of *M. glossinae*, which seize instantly any newly emerged female with the right pattern, for no courtship takes place. The new species exhibits in both sexes a far greater restlessness and activity than *M. glossinae*, the males of the former taking to flight on the slightest chance of escape, whereas the males of the latter species rarely do so unless they feel a sudden stir of air. As a preliminary to coitus the male *M. glossinae* grips the female round the neck with his mandibles, girdling her body with his legs. The attitude in the case of the new male is different, for he secures his partner with his mandibles round the abdominal pedicle. As with other species of *Mutilla*, the males of both attempt at times to bear away the female on the wing, a habit probably playing an important part in ensuring the distribution of the species. I have several times taken males and females together in the air, and on one occasion found two *in coitu* on a blade of grass standing in the lake some little way from the shore, whither the female could only have been transported by the male.

There is good reason to hope that *morsitans* pupae have been experimentally parasitised by these insects also, for a number of them to which females of the *Mutilla* have had access exhibit at a point midway between the poles the tiny shining and rather sticky patch which one sees sometimes also in the case of pupae parasitised by *M. glossinae*.

[*This species is described on p. 93 by Mr. R. E. Turner as *Mutilla benefactrix*, sp. nov.—Ed.]

Syntomosphyrum glossinae, Wtrst.

Evidence confirming completely my previous opinion that these insects are hyperparasitic on *Mutilla glossinae* has now been obtained. On 20th June a large number, comprising both sexes, were bred out from a tsetse pupa found in the vicinity of Monkey Bay, pairing taking place forthwith. A number of pupae suspected of being parasitised by the *Mutilla*, one with the cocoon of the latter showing through a fracture of the puparium, were put into two boxes, each containing two female Chalcids and one male, and the act of oviposition was shortly afterwards witnessed, the female re-opening, by means of the hard pointed extremity of its abdomen, the perforation made and sealed by the female *Mutilla*. The operation took some hours, and it was possible day by day to note the position of the pupae on which the Chalcid was sitting and afterwards to set them aside, so that in a number of instances precise data are available. In no case did emergence of the offspring take place through the perforation utilised for oviposition, but a fresh opening was bored, usually at either end, and in four cases the offspring emerged through two separate openings. The female Chalcids were readily dealt with in captivity, surviving till the first week of July, a period of about two weeks.

The evidence shows that the *Mutilla* may be attacked by the Chalcid at any stage in its development, whether as larva or pupa. This has been confirmed further by an examination of the pupa-cases from which the Chalcids had emerged. A majority of these showed within no vestige of the *Mutilla*, indicating that it had probably been attacked in the larval stage, while about 20 per cent. exhibited the cocoon with the tiny perforation at one end.

The fecundity of these Chalcids would seem, as in other cases, to be a measure of the keenness of the struggle for existence, for though no less than 2,340 wild pupae have now been obtained, in one instance only have they yielded the insects. The proportion of empty pupa-cases that seem to have contained them is higher, for out of 9,285 found between 7th April and 2nd June 351, or about 3 per cent., showed the pinpoint opening, while it was seen in 63 of the 7,731 pupa-cases (less than 1 per cent.) found from 22nd August to 16th October.

Further confirmation of the rarity of *Mutilla glossinae* in the proclaimed area is afforded by the absence of pupa-cases showing evidence of this attack.

I am carrying on the strain of *Syntomosphyrum* with a view to ascertaining their action in regard to pupae parasitised by the new *Mutilla*.

Eupelminus tarsatus, Wtrst.

From a total of 1,210 living pupae collected at Monkey Bay up to 2nd June a single one yielded one of these insects. But since then three more pupae out of an additional 762 collected in the same neighbourhood have yielded them, two pupae containing two females each, and the third two males and five females. The advent of the males and the facility with which the insects can be kept alive in captivity have made it possible to ascertain the part they play in the life-history of *morsitans*.

As with the other parasites considered, coitus took place very shortly after emergence and prior even to feeding, and the females commenced to oviposit in *morsitans* pupae within a couple of hours. They were supplied with a large number

of pupae believed to have been parasitised by *Mutilla glossinae* and with a few new pupae obtained from captive flies. Among the former there happened to be, as I subsequently discovered, a pupa with a small fissure produced as the result of rough handling with forceps, and on this one of the *Eupelminus*, after leaping hurriedly from pupa to pupa, immediately stopped. Having examined the place and then the rest of the pupa critically with its antennae, it immediately inserted its ovipositor, partly withdrawing it after a very short interval and re-inserting it several times with its body bent first to one side and then to the other, as if depositing ova in various situations within the pupa. The operation took about two minutes only, after which it went on to attack other pupae. On no bred pupa was more than a very cursory examination bestowed.

Careful puncture of such a pupa with the point of a very fine pin did not lead to any action by the parasite, though the injury was detected at once and examined with the antennae. A new pupa rubbed with fluid from a Mutillid larva and then punctured did not induce attack either. Certain of the pupae, however, definitely attracted the parasite, for it frequently happened that, after having oviposited through one puncture, the insect would examine all the pupae provided, one after the other, and then return to the pupa first punctured, re-inserting its ovipositor close to the same spot. In two cases three punctures all close together could be seen with a high power lens.

These insects appear to be long-lived, some being still alive nearly a month after emergence, and they are easy to deal with in captivity. All the nine females oviposited in pupae of *G. morsitans*, and a large number of offspring emerged, 22 males and 58 females ; in every instance except one, the cocoon of a *Mutilla glossinae* could be seen within the *Glossina* puparium from which they emerged. The figures do not in all probability afford a correct estimate as to the fertility of the hyper-parasite, for a number of pupae which were seen to be attacked have as yet yielded nothing, and specimens of *Eupelminus* emerge every now and again from pupae which have been in my possession for months. In the case of the specimens for which exact data could be obtained the period from oviposition to emergence varied from 28 to 32 days, the greatest number obtained from a single puparium being nine.

The attack has not always been successful, for in several instances Mutillids have emerged from pupae into which an *Eupelminus* has been seen to thrust its ovipositor, and in two cases tsetse-flies have emerged from such pupae.

The relative size of the female offspring seems to be determined by the number which have fed up in each pupa, for when only one has emerged it is invariably found to be at least double the size of those which have emerged in threes and fours.

Large Chalcids (Stomatoceras spp.).

These parasites are by no means abundant, for five, possibly six, only emerged from 1,210 pupae found in the Monkey Bay vicinity between 7th April and 2nd June. The pupae found in the proclaimed area did not yield any at all, and the pupae found subsequently at Monkey Bay have only provided two. One of these on being placed with *morsitans* pupae exhibited much excitement, and having examined the pupae with its antennae, thrust into one its ovipositor, an instrument so efficient for its

purpose that the operation only occupied a moment of time. It then punctured several more pupae, no special region being selected. In several instances it returned to a pupa previously punctured and again thrust in its ovipositor through a different perforation. Hitherto no more than one of these Chalcids has been bred from a single pupa.

The precise relationship of *Stomatoceras* to *G. morsitans* is still undecided. In the case of four specimens bred recently, two of the *Glossina* puparia certainly contained cocoons of a *Mutilla*, but the two others contained remains of a *Glossina* imago. On the 7th October a *Stomatoceras* was seen to oviposit in two puparia, and on carefully chipping these a *Mutilla* cocoon was seen within. In seven other puparia from which *Stomatoceras* emerged, one showed unmistakable signs of a *Mutilla* cocoon; three were empty, except for unrecognisable debris; and three contained remains of *morsitans*, in one case a fully developed fly being completely hollowed out. A possible explanation of these facts is that a pupa once attacked by a *Mutilla* may be hyper-parasitised by the *Stomatoceras* at any stage in the development of the former.*

Parasitic Bombyliids.

No results have so far attained my efforts to ascertain definitely the part played by the various parasitic species in reference to *morsitans*. Large numbers have been caught during the last couple of months at the few spots where flowers are now to be found, and some have been kept alive in captivity up to three weeks, so that I expect to be able to settle the question later.

Breeding Season.

There has been no definite cessation in the production of pupae throughout the dry season, though very small numbers only have been obtained from a long series of captured flies. Emergence has occurred throughout. Now, as the dry season draws to a close, pupae are being produced more freely.

Relationship of the Fly to the larger animals.

Having worked mainly in districts where some game is constantly to be found, one is perhaps hardly in a position to express an opinion as to whether or not its presence is vital to the fly, but it is a frequent experience that an abundance of flies usually indicates the presence of game or that game has recently been in the neighbourhood. I believe that a habit of following herds of game is the explanation of a fact known to all who travel frequently in fly areas, namely, that on some days, when the air is perfectly still, flies are met with in abundance, whereas a day or two later perhaps, under the same conditions, only a few may be met with. In passing along open roads with a breeze blowing the numbers of the fly hovering round seem to me to some extent to be determined by the direction of the wind, the flies scenting one better with a following or head wind than when the breeze blows directly across one's path.

*[A more probable explanation is that the *Stomatoceras* is a super-parasite or competitive direct parasite of the *Glossina* which by its quicker development can beat the *Mutilla*, and may indeed incidentally attack the larva of the latter.—Ed.]

It is frequently said that the fly is to be found in regions where the game is "practically extinct" or absent, but I would point out that such expressions are usually employed from the hunter's point of view and more often than not are to be interpreted as meaning that game is not sufficiently abundant as to make shooting worth while, when so much can readily be obtained elsewhere, or that such game as there is has become excessively wary from continual persecution. In the wet season the height of the grass, which renders all except the main paths impassable, makes it difficult to form any opinion as to the amount of game present, and in the dry season much of the ground gets baked almost as hard as stone, so that the smaller animals leave no spoor.

The powers of flight of the fly are good, and it is probably able to detect its prey, when it requires food, at a long distance, a faculty that may be an important factor in determining its well being, especially in the female, which tends to seclude itself in the later stages of pregnancy. The elaborate antennae, and the special sense-organ connected with them, which, judging by the habits of the male are not employed for the purpose of discovering the opposite sex, would seem to bear this out. Its food is in concentrated form and of the highest possible energy value, so that it requires a meal every five or six days only. The presence of a large number of game animals is not therefore essential to its existence.

In all the districts in which the fly has been studied, baboons occur sometimes in very large troops, and the presence of pupae in some numbers among the rocks which these animals frequent may indicate that the fly derives some subsistence from them, especially as they occur in places where other animals are largely absent.

With regard to the other possible sources of food, it is difficult to believe that any material amount can be derived from birds, for captive flies in wide-mouthed jars when afforded an opportunity of feeding on fowls have the greatest difficulty in obtaining blood through the feathers, so that probably certain birds only, *e.g.* vultures with bare necks, ever afford a meal in nature.* Moreover, in a series of 300 flies containing recognisable blood examined by the Royal Society's Commission avian blood was only found in 1 per cent.†

The supposition that various cold-blooded animals may supply blood seems to be negatived by their very scarcity. The larger lizards, monitors for example, which I have often studied elsewhere, are here extremely rare, for I have seen four only in the course of the year. Agamid lizards are by no means common in the fly areas, and one can hardly conceive seriously of the active little LACERTIDAE, which are numerous, as contributing materially to the food supply of the fly. A test with toads and with various tree-frogs proved negative. Other reptiles, which are scanty, need hardly be taken into consideration.

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*[Compare the observation by Mr. Ll. Lloyd on p. 77.—ED.]

†[The evidence that *G. morsitans* does not normally feed on non-mammalian blood is not quite so conclusive as might appear from these statements. In Northern Rhodesia, Kinghorn, Yorke and Lloyd record (Ann. Trop. Med. Par. vii, 1913, p. 282) that out of 82 flies containing recognisable blood no less than 12, or 14·6 per cent. contained nucleated red cells. Moreover, the preference of *G. palpalis* for reptilian blood, which has been clearly proved by observations in the field—quite contrary to the laboratory results—shows how dangerous it is to make assumptions as to the natural food of these insects based merely on the behaviour of captive flies under unnatural conditions.—ED.]

Artificial Breeding Places.

A large number of these have now been constructed. At Rifu, in the proclaimed area, twelve large trees, comprising ten species, were felled in early August at distances of about a quarter of a mile apart along the old path running from Kuchuru to Maganga's, and the ground beneath them was thoroughly loosened and pulverised. Twelve more trees were felled at the same time along the path running down the south boundary of the Lingadzi estate towards Kasache. In this locality there was very little choice in regard to the species of the trees, so that ten of the twelve were the same.

The greater part of this work has however been carried out in the vicinity of Mzeze, close to Monkey Bay, where an attempt has been made to establish the breeding places on a definite scale. The locality was selected because it is traversed by the main path to Dedza and the north, because the various types of country affected by the fly are present, and because in this neighbourhood I am best acquainted with the fly distribution, outside the proclaimed area.

The proximity of breeding places to paths in this country does not in my experience result in material increase in the number of pupae found therein, for except along the trunk roads there is very little traffic, the natives having no trading instincts and little tendency to wander far afield from their villages. So far as possible however breeding places have been placed along the roadside, but the game paths which run in all directions were too sinuous so to be dealt with.

The work was commenced by cutting a base line of a mile running N.W., the road deviating to such an extent, in spite of the absence of natural obstacles, first on one side of this general direction and then on the other as to be useless for my purpose. From the base line on the east side eight parallel traverses running due east were made in the mile, being marked in such a way as to be found easily at any future date, and along each of the traverses eight breeding places, and in some cases ten, spaced as regularly as possible, were formed by felling trees of various kinds. The first three traverses pass through woodland composed of low shrubs growing so densely as to make one's passage difficult, and the remaining five pass through thorn-bush country.

The second square mile is on the opposite side of the road and contains four traverses, each running due west, with four artificial breeding places along each. Two run through dense woodland and two through thorn-bush.

In some of these breeding places the natural soil has been replaced by soil brought from natural breeding places, and in others the earth has been well mixed with fragments of rotting wood and bark, with earth from termitaria, and with antelope droppings, the latter method being the only available means of imparting an odour of game to the places, with the idea of ascertaining whether the choice of the fly can be in any way influenced.

In both of the square miles the great majority of the natural breeding places have been eliminated, pupae and pupa-cases having been previously collected. The work of disposing of the fallen trees turned out to be easy, for fires made of collections of portable timber piled up round the larger trunks smouldered away for days, and in most cases required to be tended once only before all was consumed.

Effect of Bush Fires on the Distribution of the Fly.

On my return to the proclaimed area in the first week in June, I found that the abourers who had been employed in clearing the road running west from Domira Bay had fired the grass and that the flames spreading before the southerly breeze, which seems to blow at this season almost constantly from that quarter, had extended right up to the chain of villages along the banks of the Lipimbi to the north, where they had died out at the edge of the clearings round the villages. The result was a marked diminution in the numbers of flies in the burnt area, so much so that one was almost free from attack when hunting for pupae, of which a fair number were obtained. But on camping at the spot where on the banks of the river I have stopped previously in comfort for weeks, I was so beset with flies in my tent that I found it necessary to move, and the natives informed me that they were bitten occasionally in the villages, even though there were extensive clearings all the way round. I have no doubt that the flies had come in partly as a result of the fires and partly owing to the driving away of the game. But apart from these flies there were pupae enough under logs untouched by the fires soon to repopulate the burnt area. In the Lingadzi area, which had not been burnt, I was so beset by the fly on proceeding to make artificial breeding places that I gave it up for the time being and fired the grass extensively, the result being that two days later two flies only were encountered.

I endeavoured to obtain evidence of the retreat of the flies before the flames by shooting some of the birds which are attracted in considerable numbers to hawk insects driven out, but I did not find any tsetses in the stomach contents.

I may remark incidentally that by obtaining birds under these conditions one finds the stomach absolutely packed, so that ample evidence as to what insects birds do really eat could readily be obtained.

The flames are not to any extent instrumental in burning up the dead trees which form so large a proportion of the breeding places, the fact being that the fires are too fleeting as a rule to do more than just char most of the logs, which are also protected by dust and by earthy deposits of termites.

Systematic burning of the grass is not in my opinion likely to be of value for controlling the fly, because over much of the fly country the grass is patchy, so that the fires fail to spread, and in some regions it will not burn till late on in the dry season, when the fly is able to find refuge in areas burnt long before.

Where the fires have been extensive, most of the game seems to be driven off and to remain for the time being in other parts, with the exception of wart-hog, which then grubs up roots. This animal therefore probably provides food for the newly emerged flies.

Proportion of Sexes.

Confirmation has now been obtained of the theory—which as I now see was originally advanced by Lloyd (Bull. Ent. Res., iii, p. 235)—that the male flies, the majority of which I have found to be replete and which do not attempt to bite, attend on possible hosts in the anticipation of securing females coming to feed. When the host rests, so that there is less likelihood of the females being attracted, the majority of the flies retire.

The males do not hesitate to attempt to pair with the females whatever their condition, so that in the case of the females, those at all events which are pregnant, there must be a constant effort to evade capture, for there is no mechanical device, such as the sphragis of the Acraeine butterflies, to protect them when once fertilised against further assault, which in the case of captive females seems to render them liable to abort.

As I have before noted, marriage takes place by capture, and as in such cases with other insects (the Acraeinae, for instance) the female is seized in the air, pairing taking place when the couple fall after a flight of variable length. This explains how it is that the sitting female flies escape molestation. I have repeatedly noticed that a female with flaccid wings introduced into a jar containing males is not troubled so long as it holds on to the gauze over the mouth, whereas if such a female is dropped in, so alert are the males, being on the *qui vive* perhaps on account of its note of protest at being handled, that it is seized even before it reaches the bottom.

It is a common experience when one is moving that some of the flies, presumably all males, which have been hovering round have suddenly formed a buzzing knot and have temporarily disappeared, vieing with each other presumably for the possession of newly arrived females, and it was thought probable that in the event of a female being anxious to evade capture by them it would settle in the vicinity, awaiting a further opportunity to make an attempt to feed.

The readiest method of obtaining tsetses is for the collectors to catch them off each other, and this is doubtless the method adopted by most workers, the results showing that the females invariably bear a small proportion to the males. The following table gives the data within my own experience bearing on the point:—

Locality.	Season.	No. of days.	Males.	Females.	Approximate % of females in total captures.
Matumbas, Proc. area	Nov. 1914 (dry)	8	346	135	27
Lingadzi, Proc. area	Dec. 1914 (dry to wet)	13	1694	295	15
Lingadzi ..	Feb. 1915 (wet)	12	1788	264	12
Monkey Bay ..	May 1915 (dry)	12	1598	84	5
Monkey Bay ..	Nov. 1915	8	651	28	4

It is recorded also in the report (no. 16) of the Sleeping Sickness Commission of the Royal Society that during five days in October 1912, Staff-Sergeant Gibbons took in the proclaimed area 472 males and 69 females, thus approximately 12 per cent. being females.

But very different figures are obtained if captures of flies which have settled near to the possible host are included. As the easiest method of securing these an umbrella, under which the flies will settle at any time during the day, was carried, and a series of captures was made daily from 7 to 11 a.m. and from 3 p.m. to dusk by two boys, one carrying the umbrella and the other catching the flies, while at the same time two other boys a short distance away took flies in the usual way off each other. The results tabulated below are striking :—

	Flies caught 7 to 11 a.m.				Flies caught 3 p.m. to dusk.			
	Under umbrella.		In usual way.		Under umbrella.		In usual way.	
Date.	♂	♀	♂	♀	♂	♀	♂	♀
23 Nov. ..	41	21	25	6	17	13	25	0
24 ,, ..	19	15	39	3	30	14	18	4
25 ,, ..	44	28	37	4	48	19	40	6
26 ,, ..	53	24	49	0	20	26	24	1
27 ,, ..	16	7	14	7	9	2	11	2
29 ,, ..	30	17	35	3	16	3	14	0
Totals ..	203	112	199	23	140	77	132	13

The proportion of females captured under an umbrella works out therefore at about 35 per cent. for the morning and 35 per cent. for the afternoon, whereas when captures were effected in the usual way the percentage fell to 10 for the morning and 9 for the afternoon. None of the females showed evidence of having fed recently.

During the heat of the day, from about 11 to 3, the numbers of *morsitans* on the wing are much diminished, as is shown by data given in a subsequent paragraph, but I have never found that, as stated by Lloyd in his notes on the species in the Luangwa valley (Bull. Ent. Res., iii, p. 235), they then disappear except in deep shade, for they have been obtained here on the hottest days with a still atmosphere, and isolated flies may even be encountered over dambos and cleared spaces in the fly areas. The idea then suggested itself to me that an investigation of the sheltering media used at this time by the flies might throw further light on the special habits of the females, seeing that though the sexes emerge in about equal proportions from pupae both bred and obtained in natural breeding places, the males still exceed the females even when the flies are captured by a special method.

There is no evidence of female migration to account for this, and over the greater part of the fly area of Nyasaland migration hardly seems possible, unless it takes place to the east over many miles of open water or to the west over mountain ranges and many miles of open country, for series captured down a stretch of 150 miles of the area which runs north and south have always given about the same low percentage of females.

Careful examination of thorn bushes and other low trees failed to reveal the presence of sitting flies, but they were found on the larger trees, baobabs in particular, and a first impression that the females here occurred in greater proportion has been confirmed by a series of captures, which have shown that occasionally they may even exceed the other sex. The females are to be seen deep in the recesses between the buttresses and component parts of the trunk, and in the hollows and fissures of the bark of the older trees, and they often occur high up and far out of reach. The males on the other hand seem to rest as a rule in more obvious positions. During the cooler hours both sexes can still be found, but they are by no means so numerous.

For the sake of comparing data, captures were effected for six consecutive days, from 7 to 11 a.m., 11 to 3 p.m., and from 3 p.m. to dusk (about 6.30), on each occasion by four boys under supervision. During the morning and evening shifts flies on the collectors and hovering round them were taken. During the mid-day shift the collections on three days included flies taken off baobabs and on the journeys to and from camp; on the fourth day flies off baobabs alone; and on the fifth and sixth days flies off certain other trees as well as baobabs. The data are given in the table on page 43.

The proportion of females captured in the ordinary way during the morning and evening hours works out at 12 per cent. and 10 per cent. respectively, whereas when the flies were taken during the mid-day hours, mostly off trees, a percentage of 43·5 was reached, a close approximation to equality.

It was very obvious that a far greater number of the female flies caught on the trees had recently fed than of those captured otherwise, and there was a marked difference in their behaviour when placed in jars, those off the trees remaining quietly sitting on the side when the hand was placed over the jar, whereas the second series became clamorous at once, running to and fro over the gauze and from time to time thrusting through their probosces. In view of the importance of the question I made some attempt, as will have been seen in the table, to estimate the degree to which the female flies in each case were replete. I must admit however that an estimate of this kind is necessarily liable to serious error, for, other considerations apart, there is the question of pregnancy to be taken into account, and many have since produced larvae; though it is easy enough to distinguish a newly emerged fly, or one that has not fed for some days from one that has fed a day or two before.

TABLE OF DATA.

Date.	Flies captured in usual way.			Flies off trees.			Flies captured in usual way.		
	7 to 11 a.m.		Remarks.	11 to 3 p.m.		Remarks.	3 p.m. to dusk.		Remarks.
	♂	♀	on ♀	♂	♀	on ♀	♂	♀	on ♀
15 Nov. ..	117	2	All empty	23	15	7 replete	39	2	1 ½ replete. 1 empty.
16 ,, ..	42	4	,,	22	25	13 fully replete	26	3	All empty.
17 ,, ..	102	8	,,	30	16	9 fully replete	42	8	3 ½ replete.
18 ,, ..	54	11	,,	26	42	31 fully replete	29	3	All empty.
19 ,, ..	79	23	4 ½ replete 7 ¼ ,, 12 empty	27	13	4 fully replete 5 ½ ,,	65	5	,,
20 ,, ..	35	9	All empty	32	12	7 replete 5 ½ ,,	45	6	2 ¼ replete. 4 empty.
Totals ..	429	57		160	123		246	27	

Details as to further captures during the heat of the day from baobabs and two other species of large trees, on each occasion by four collectors, are given in the following table :—

Date.	Flies off trees.		Remarks on Females.
	Males.	Females.	
22 Nov.	10	3	All replete.
23 ,, ...	9	11	8 ,,
24 ,, ...	11	19	10 ,,
			3 ½ ,,
25 ,, ...	15	18	14 ,,
26 ,, ...	14	25	12 ,,
			11 ½ ,,
27 ,, ...	24	29	18 ,,
			7 ½ ,,
Totals	83	105	

In this series the females amounted to no less than 55·8 per cent. of the total catch.

Data concerning the flies taken on the wing at the same time by the same collectors while walking between the various trees, which are usually few and far between, are given below :—

Date.	Flies on the wing and on collectors.		Remarks.
	Males.	Females.	
22 Nov.	10	6	None replete.
23 ,, ...	15	2	,,
24 ,, ...	7	2	,,
25 ,, ...	8	5	,,
26 ,, ...	14	6	,,
27 ,, ...	5	2	,,
Totals	59	23	

In this series the females form 28 per cent. of the total captures, and the figures demonstrating that a relatively greater number of females are abroad during the hot hours lends support to the argument, which is further borne out by a little evidence tending to show that females may be taken in greater numbers in the ordinary way on the outskirts of the fly areas. Captures were effected in two localities on the same days by an equal number of boys, two in each case, the flies being abundant at one of these places (west of the road) and always scarce at the other (east of the road). The results are tabulated below:—

Date.	Captures east of road.		Captures west of road.	
	Males.	Females.	Males.	Females.
29 Oct.	26	3	188	7
30 "	10	4	66	3
1 Nov.	15	1	87	1
2 "	8	4	39	1
4 "	8	1	95	5
6 "	10	3	46	5
7 "	15	1	47	3
8 "	19	1	83	3
Totals	112	18	651	28

The proportion of females in the total captures works out in the first case at nearly 14 per cent., and in the second at 4 per cent.

The sum of evidence therefore goes a long way towards establishing what becomes of the missing females, and I am convinced that were it possible to include the females which one so often finds alone at breeding places, equality would be attained.

The following is the suggested interpretation of the facts observed:—The males, most of which are already replete, attend man largely to await the arrival of females coming to feed, hence the inequality in numbers in ordinary captured series; for whereas the males have a double object, the females have that of feeding only. On arrival the female may be secured by one of the males, or if pregnant, may be driven away in its endeavours to escape their attentions, then settling near by and renewing its attempts to feed from time to time. Having fed, it retires to the shaded recesses of large trees or to breeding places more or less remote from where the flies happen to be massed at the time, its object being to keep free from the males. As there is so great an increase in the numbers of the females taken off the trees and by other special collecting methods, it is practically certain that the sexes exist in the same area in equal numbers in accordance with the expectation from laboratory results.

Lines for future research.

An important point for future investigation will be as to the varieties of trees on which the flies settle for a lengthy rest, for hitherto in the Monkey Bay district I have found three only, the baobab, tamarind, and a tree much like our English plane. The baobab, which is especially favoured, affords comparatively dark well-shaded hollows in which the fly can rest comfortably and more securely than in more exposed situations. The general scheme of colour of the fly approximates so closely to that of the bark of these trees as to make it difficult to detect the sitting insects, a fact probably of material importance, seeing that the replete and gravid flies are quite unable to run with the vigour they exhibit under normal conditions, and fly slowly and heavily and by short stages only. On the other hand, though the coloration of the fly does harmonise exceedingly well with that of the tree, it is by no means easy to distinguish the insects on various other trees which, so far as I have yet ascertained, are not regularly favoured. No trees exhibit commonly the recesses usual in the case of the baobab, and the fly must be cooler and more sheltered from the breeze than it would be on the small trees and bushes.

It is obvious that any attempt to control the fly by systematic capture would be more likely to meet with success if the flies were taken off the trees, but at the hours most favourable for such work it is so exceedingly hot that I very much doubt whether natives could ever be persuaded to carry on such work systematically and thoroughly. The ground is unpleasantly hot even to the European's foot protected by heavy boots, so that it is not infrequent to see natives jumping from tuft to tuft of dead grass in the hope of obtaining relief. It has been a matter of difficulty to get carried out even the small amount of such work that I have found necessary.

I am now about to test the value of bird-lime traps on these trees.

The Breeding Season.

Judging by the number of pupae now obtained (October 1915) from captive flies, the breeding season for *G. morsitans* is in full swing, just as the rains are about due, and there is a marked shortening of the pupal period, which now averages about 21 days only, my figures being based on data obtained from 30 bred pupae. It seems that much earlier in the dry season the pupal stage may last certainly as long as ten weeks, hence, as I have previously pointed out, the discrepancy in figures which various workers have given.

This variability in the rate of development obtains also in the case of *Mutilla glossinae*, *Eupelminus tarsatus*, and the *Stomatoceras*, and doubtless enables the race to tide over the trying period of the dry season when the conditions of life must threaten the existence of the imagos.

Glossina morsitans and Large Game.

In the British Medical Journal of 25th September 1915 appeared a paragraph stating that a large area of territory in Nyasaland has been thrown open for free shooting and that a thorough endeavour is to be made to clear this of tsetse-flies by driving out or killing off the game. The territory referred to, a portion of which I examined last year, is situated in the Marimba district and is said to be richer in game than any other part of the Protectorate.

I take this opportunity of expressing the opinion that no definite result whatever can be obtained by the measure. The fly area is continuous with large areas in North-Eastern Rhodesia. The territory is very extensive and sparsely populated, and the game, if severely harassed, will retire to Rhodesia during the dry season, when only it is possible to hunt, returning in the wet, and probably bringing more flies with it.* As professional hunters have informed me, this movement is known to occur with the larger game, elephant in particular.

A very small party of white hunters is likely to be available, so that, so far as I can see, the only outcome will be unlimited and free shooting for the few fortunate people who happen to be within easy reach of the game country.

SUPPLEMENTARY REPORT.

Resting Habits of Glossina morsitans.

The resting habits of the flies, as described in my last report, have been further studied at Monkey Bay, at Rifu, and other localities with a view to ascertaining whether any trees other than the three species favoured by the flies near Monkey Bay are utilised. It has been found that, though baobabs are certainly preferred, any other large tree will serve. In the neighbourhood of Rifu baobabs are absent. It seems that large trees only are utilised, for no flies have been found resting other than momentarily on the thorn and other bushes which make up so largely the wooded country occupied by the insects.

The stomach contents of ten lizards captured on baobabs in the fly area were examined, but in no case were tsetse remains found.

Attempts have been made to take advantage of the resting habits of the flies by fixing in the recesses of various baobabs on all sides sheets of brown canvas-backed paper smeared with birdlime, and well protected by thatch from sun and breeze. A few flies were caught by this means, but the results were disappointing.

Thatched shelters, birdlimed on the inner side, were also put up close to the trees, some high up on poles, others at a lower level, but no results were obtained, nor were many flies caught when such shelters were carried during the heat of the day in fly infested country.

Artificial Breeding Places.

Results have now been obtained. At Lingadzi, as already reported, twelve trees, ten of which were of the same species, were felled in August last and arranged as

*[In this connexion the result of a very similar experiment in Southern Rhodesia is worth noting. The fly areas in the Mafungabusi district were recently thrown open to indiscriminate shooting for one year. At the end of that period the Government Entomologist visited the locality in order to report on the results; he found that no appreciable diminution of the game, with the exception of elephant, was yet apparent, and the tsetse appeared to be still extending its range in continuance of the movement noted during the past eighteen years.—Ed.]

artificial breeding places. From beneath nine of these no less than 59 living pupae of *morsitans* and 39 cases were obtained a few days ago [January 1916], the remaining three trees being unapproachable on account of floods. The number of pupae there obtained have exceeded expectation, and it would almost appear as if the flies had exercised a judicious selection in their choice of places for the reception of their pupae, preferring artificial ones which fulfil presumably all their requirements to the natural ones, many of which cannot in respect of drainage, protection from sun and rain, etc., be as wholly satisfactory. The country at Lingadzi is of the type most favoured by the fly in this Protectorate.

From the twelve similar breeding places comprising ten different species of trees felled near Rifu 20 pupae and 19 pupa-cases were collected at about the same time, no tree in particular being favoured. A larger number was hardly to be expected in this locality, owing to the stony nature of the soil and the numerous natural breeding places afforded by rocks.

Thirty of the artificial breeding places arranged on a large and systematic scale over two square miles near Monkey Bay, which were recently searched, yielded 98 pupae and 34 pupa-cases, an average of about four to each place. But, as I have before noted, there has been a very marked falling off in the numbers of the flies in the neighbourhood recently, so much so that one may now pass along the road running north with almost complete immunity from attack, whereas nine months ago a buzzing swarm of flies invariably followed in pursuit. This, as I believe, has been brought about by the agency of the parasite *Mutilla glossinae*, Turner, which in August and September was found to have parasitised a very high percentage of the pupae. It is not attributable to any withdrawal of the game, for several small herds of water-buck, female kudu, and three large herds of eland, besides wart-hog and the smaller antelopes, bush-buck, impala and duiker were to be found almost day by day.

The possibility of checking the flies through artificial breeding places has therefore been established, the results at Lingadzi almost suggesting that control could be effected without the expense of eliminating other than the larger natural breeding places. One realises of course the impracticability of the application of the method over the vast fly area of Nyasaland, which, as I see in the report of the Sleeping Sickness Commission of the Royal Society, is estimated at 5,000 square miles, but it would certainly seem feasible to employ it over small areas, those in proximity to trunk roads or to important centres. The high road from Zomba to Fort Johnston, for instance, runs for several miles to the north of Liwonde through a fly area, which then deviates from the road, the country being less favourable to the fly. To the east the area is limited by the river Shire at no great distance, and to the west by hills and by more open country, not more than a mile or two away, so far as memory serves me. It should be possible to make a broad clearing at either end of the area where it touches the road, and then artificial breeding places should be constructed within the area so cut off. The possibilities of the transfer of flies across the clearings by moving game might perhaps be obviated by means of a wire fence.

Some similar measure may be required when, as anticipated, the projected railway from Blantyre is carried north through the fly area. I have repeatedly noticed in the Southern Provinces of Nigeria that the railway is responsible for the transfer from place

to place of *Glossina palpalis*, the flies frequently travelling in the carriages. It is to be supposed too that they there accompany cattle brought in open trucks through the fly areas in the north for slaughter in the south.

Expulsion of the flies might possibly be effected through the elimination of the larger trees favoured by the flies as resting places. Much of the fly area does not seem favourable to the growth of these trees, so that they are comparatively few and far between, and the measure is not so impracticable as might be anticipated. Baobabs on account of their gigantic girth would offer the main difficulty, but this could doubtless be overcome by the use of explosives.

A more ideal method would of course be the felling of all large trees and their utilisation as artificial breeding places, but the disadvantage would be the difficulty of discovering all at such times as it became desirable to collect the pupae.

Parasites.

I have endeavoured within the last few days to ascertain further whether *Mutilla glossinae* is included among the Mutillids found in the Proclaimed Area. A large series of species of this family has been obtained over a stretch of sandy soil about half a mile long and 200 to 300 yards broad surrounded on all sides by lower lying ground, now swampy. *M. glossinae* is not among these, but the astonishing number of various Mutillids found doubtless indicates the modifying effect of ground water-logged in the wet season on the distribution of these insects.

Three female *M. glossinae*, which emerged from wild *morsitans* pupae on 5th, 11th and 19th October respectively, were paired with a male on the day of emergence and kept in jars each containing twenty pupae deposited by captive flies between 20th October and 8th November.

Three offspring of female A, all females, emerged from the pupae between 7th and 11th December. Five offspring of female B, two males and three females, emerged between 8th and 20th; and three, a male and two females, the offspring of female C, emerged between 19th and 24th December. Tsetse have emerged from many of the pupae, but there still remain some which may yield more Mutillids at another season.

Though this breeding experiment confirms previous results I am not of opinion that it affords adequate evidence as to the fertility of the parasite, for the females did not thrive in captivity, as did others early in the dry season, and in consequence various other experiments of a like character were brought to a premature close. A far lower percentage too have emerged latterly from pupae found in the vicinity of Monkey Bay.

Various captured specimens of the Bombyliid fly, *Thyridanthrax abruptus*, Lw., were placed between 19th and 30th November in jars containing pupae deposited by captive flies between 7th and 14th November. On 20th December one of the offspring of these flies emerged, and between that date and 24th three more. This Bombyliid is therefore a direct parasite of *morsitans* pupae.

The flies are by no means easy to deal with in captivity, for they dash themselves wildly against the sides of the jar, so that they soon lose all the hairy covering of the body and the wings break off short, but some feed freely and can then be kept alive up to a week.

A further difficulty in regard to all the parasite work that has been undertaken has been that it has necessarily been conducted under the disadvantages of life in a tent.

[The interesting and valuable investigations which are being carried out by Dr. Lamborn, at considerable personal risk, in the Sleeping Sickness Area of Nyasaland have been temporarily suspended, his services having been lent by the Imperial Bureau of Entomology to the East African Expeditionary Force.—Ed.]

OBSERVATIONS ON SOME RECENTLY DESCRIBED COCCIDAE.

By E. Ernest Green, F.E.S., F.Z.S.

Pseudococcus bicaudatus, Keuchenius, Medel. v.h. Besoekisch Proefstation, Djemba, No. 16, 1915, p. 63 [see also Review of Applied Entomology, Nov. 1915, p. 647].

The author's detailed description of the supposed new species shows quite clearly that he is dealing with *Pseudococcus virgatus*, described by Cockerell in 1893. The species occurs commonly throughout the tropics of both hemispheres and has been described by different authors under several names, e.g. *ceriferus* (Newstead), *talini* (Green), and *marchali* (Vayssière).

Fiorinia morrisi, Brittin, Trans. N.Z. Inst., Wellington, xlvii, 1914 (issued July 1915), p. 149 [see also Rev. Appl. Entom., Dec. 1915, p. 74].

Through the courtesy of the author, I have had an opportunity of examining typical examples of this insect, and find that they agree with examples of *F. asteliae* (ex coll. W. M. Maskell). *Fiorinia asteliae* is now considered to be a synonym of *F. gigas* of Maskell, and both have been rightly relegated to the genus *Leucaspis*.

Fiorinia maskelli, Brittin, loc. cit., p. 157.

After examination of specimens received from the author, I am convinced that this species also should be referred to the genus *Leucaspis*. I append drawings of the posterior extremity of the nymph (fig. 1, *a*) and of the adult female (fig. 1, *b*). I am puzzled by the author's representation (loc. cit., fig. 3) of the pygidium of the adult female. It will be seen that this agrees, more or less, with my figure of the nymph, except that it shows circumgenital glands, which, of course, are never present in the nymphal stage. The species appears to be distinct, but approaches *kermanensis* of Lindinger.

Pinnaspis nitidus, Brittin, loc. cit., p. 151.

This proves to be *Mytilaspis pyriformis* of Maskell.

Lecanium armatum, Brittin, loc. cit., p. 152.

Mr. Brittin now informs me that he has been able to identify this insect with Maskell's *Ctenochiton spinosus*.

Scutare fimbriata, Brittin, loc. cit., p. 158.

I should refer this insect to the genus *Rhizococcus*. The author describes a "puparium," but I have failed to find (in specimens received from him) anything that can be compared to a true puparium. The dorsum of the insect has a very thin coating of translucent wax which gives it a pruinose appearance, and in the early

adult female there is a more or less complete fringe of waxy lamellae. The latter character is merely an exaggeration of the condition found in *Rhiz. pulchellus*, in which species the marginal spines are said to give rise to long glassy tubes which form a fringe.

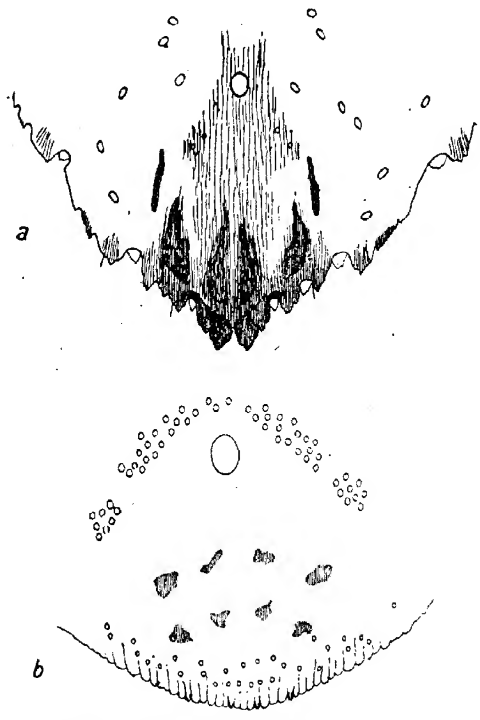

Fig. 1. *Fiorinia maskelli*, Brittin ; posterior extremity of (*a*) nymph, (*b*) adult female ; × 280.

Cryptococcus nudatus, Brittin, loc. cit., p. 160.

This name must fall to Maskell's *Sphaerococcus parvus*—now placed in the distinct genus *Kuwanina*. It is not surprising that Mr. Brittin failed to recognize his insect from Maskell's description and figures, which are quite inadequate and even misleading.

REMARKS ON COCCIDAE FROM NORTHERN AUSTRALIA—II.

By E. E. Green, F.E.S., F.Z.S.

Further collections from Mr. G. F. Hill, gathered in the neighbourhood of Port Darwin, have produced several interesting new species which are described below.

Aspidiotus destructor, Sign.

On foliage of *Pandanus odoratissimus*, Darwin, N. T. (Hill, no. 636). These puparia have a rather more brownish tint than is usual in the species.

Aspidiotus fodiens, Mask.

On *Melaleuca leucadendron*, Koolpinyah, N.T. (Hill, 17, 18), and on *Pithecolobium moniliferum*, Stapleton, N.T. (Hill, 637). In the older examples from *Melaleuca* the pygidial lobes are worn and are not of such a regular outline as in the fresher material from *Pithecolobium*, but the two forms agree in all essential characters.

Aspidiotus orientalis, Newst.

On *Ficus orbicularis* (Hill, 23), and on " Milkwood Tree " (Hill, 24), Darwin, N.T. Also " on undetermined introduced tree " (Hill, 639).

Aspidiotus unilobis, Mask.

On *Melaleuca leucadendron*, Koolpinyah, N.T. (Hill, 18, 19). And on the same plant at Stapleton, N.T. (Hill, 638).

Aspidiotus (Aonidiella) miniatae, sp. nov.

Puparium of female small, circular, moderately convex; dull ochreous white; pellicles proportionately large, reddish or reddish-brown. Diameter 0·75 to 1 mm.

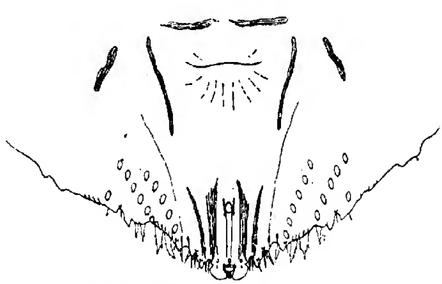

Fig. 1. *Aspidiotus miniatae*, sp. n.; pygidium of adult ♀, × 280.

Adult female broadly oval. Pygidium (fig. 1) without circumgenital pores. Median lobes small but moderately prominent, constricted at base, hatchet-shaped, the outer margin evenly rounded. Lateral lobes (three on each side) represented

by marginal prominences. Squames very delicate and inconspicuous, the two immediately following the second lateral lobe irregularly fimbriate and considerably longer and broader than the remainder, which are almost spiniform. There are five pairs of small but well-defined claviform paraphyses, situated in the spaces between the lobes. Anal orifice small, at rather less than one-third of the distance from the extremity to the base of the pygidium. Two series of oval dorsal pores on each side, running diagonally from the margin between the second and third lateral lobes. Numerous long tubular glands open on to the extreme margin. Length 0·5 to 0·9 mm.

On twigs of *Eucalyptus miniata*, Darwin, N.T. (Hill, 22).

Aspidiotus (Aonidiella) subcuticularis, sp. nov.

Female puparium completely buried beneath the cuticle of the leaf, the reddish-brown larval exuviae partially exposed. The rest of the puparium is closely adherent to and difficult to separate from the superimposed cuticle. Its presence is indicated by very inconspicuous blister-like swellings on the surface of the leaf. These vesicles have a diameter of from 2·0 to 2·5 mm. Nymphal pellicle with a denser median area.

Male puparium slipper-shaped, exposed, but sunk in a shallow pit, or surrounded by a slight tumescence of the tissues. Exuviae thinly covered with whitish secretion, with a raised white ring and central boss, and surrounded by a narrow dark brown zone. The puparium is extended posteriorly by a paler reddish-brown appendix. Length approximately 1 mm.

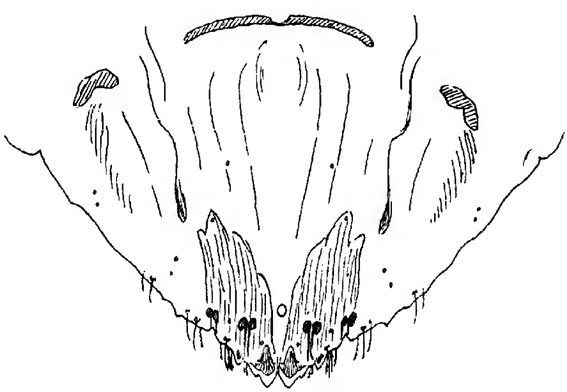

Fig. 2. *Aspidiotus subcuticularis*, sp. n. ; pygidium of adult ♀, × 280.

Adult female circular or broadly oval, the posterior extremity somewhat pointed. Rudimentary antennae with a single longish stout seta. No parastigmatic pores. Pygidium (fig. 2) deltoid, the sides converging evenly to the pointed extremity. Median lobes large and broad, closely approximated ; so deeply indented on the outer edge as to appear almost duplex. A small conical lateral lobe on each side, situated close to the median lobes. Both median and lateral lobes with a translucent marginal area. Squames small, slender and inconspicuous—two between the median

and lateral lobes, two or three just outside the lateral lobe, and one or two beyond the outer pair of paraphyses. Spines rather large and more conspicuous than the squames. Paraphyses clubbed, large and conspicuous; two pairs on each side, the inner pair longest, arising from the interval between the median and lateral lobes, the outer pair arising from an indentation at a short distance beyond the lateral lobes. Anal orifice very small, near the extremity. No circumgenital pores. A transverse series of chitinous thickenings across the base of the pygidium. Length approximately 0·75 mm.

On the upper surface of leaves of *Ficus orbicularis*, Darwin, N.T. (Hill, 23).

This insect is a true "mining scale," the puparium being completely covered by the actual cuticle of the leaf. The peculiar paired and clubbed paraphyses sufficiently distinguish the species.

POROGYMNASPIS, gen. nov.

Female puparium consisting of the enlarged nymphal pellicle, with or without a superimposed larval pellicle, but without any secretionary appendix or covering.

Male puparium with an oval or oblong secretionary appendix, with the larval pellicle situated at the anterior margin.

Posterior extremity of nymphal pellicle with prominent lobes, broad fimbriate squames, and conspicuous semilunar marginal pores, as in *Parlatoria* and *Leucaspis*.

Adult female entirely enclosed within the nymphal pellicle. Pygidium with circumgenital pores; posterior margin with small lobes and cuspidate marginal processes.

The characters of the genus associate it with *Gymnaspis*, *Parlatoria* and *Leucaspis*. It is probably most nearly related to *Leucaspis*.

The genus differs from *Gymnaspis* in the presence of circumgenital pores; from *Parlatoria* in the enlarged naked nymphal pellicle which completely encloses the adult insect, and in the absence of semilunar marginal pores on the adult female; and from *Leucaspis* in the total absence of any secretionary covering or appendix to the female puparium.

Porogymnaspis rufa, sp. nov.

Puparium of female consisting of the naked nymphal pellicle which is bright red or reddish yellow, broadly oval, highly convex, appearing almost hemispherical to the naked eye, but showing (under a lens) a profile as represented at figure 3, *a*. The larval pellicle is shed at an early stage of growth. The pygidial area is sharply defined (fig. 3, *c*) and occupies an almost erect position at the posterior extremity of the pellicle; its margin bears eight prominent but slender lobes, the median and first laterals obscurely trilobed, the second laterals obscurely indented on the outer edge, the third laterals simple. Squames broad, obscurely tricuspid at extremity. Conspicuous semilunar pores, three on each side. Length 0·75 mm.

Male puparium (fig. 3, *b*) oblong or broadly oval, moderately convex, sometimes with traces of two longitudinal ridges, whitish; the small fulvous pellicle placed close up to the anterior margin. Length 0·75 to 1 mm.

Adult female subcircular (fig. 3, *d*), posterior extremity slightly produced. Pygidium (fig. 3, *e*) with its truncate extremity bearing a close fringe of prominent tricuspid processes, of which from four to six are usually more densely chitinous than the remainder and represent the pygidial lobes. Anal orifice central. Genital orifice nearer the base. Circumgenital glands usually separable into five groups, but often forming a more or less continuous arch; the median group represented by from 1 to 5 isolated pores, upper laterals 10 to 15, lower laterals 11 to 17. Length approximately 0·5 mm.

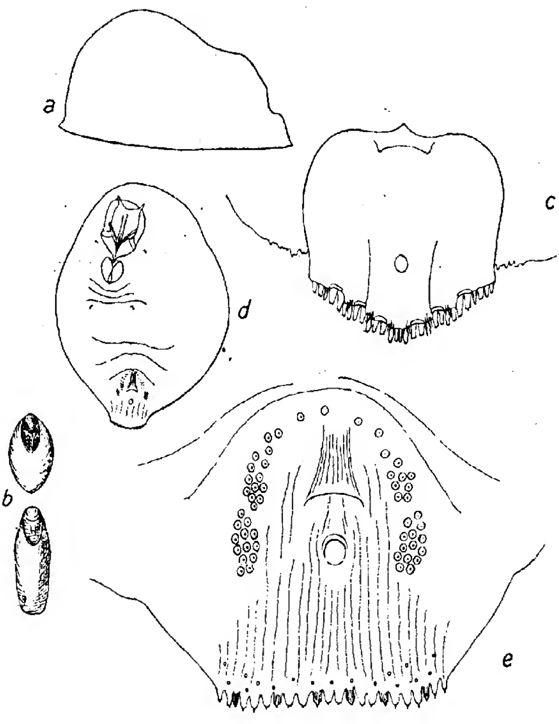

Fig. 3. *Porogymnaspis rufa*, sp. n.; *a*, profile view of female puparium, × 75; *b*, male puparia, × 16; *c*, posterior extremity of nymphal pellicle, × 280; *d*, adult female, × 80; *e*, pygidium of adult female, × 450.

Adult male not observed.

On *Pandanus odoratissimus*, Koolpinyah, N.T. (Hill, 13, 14).

A minute and inconspicuous species, occurring singly amongst a crowd of *Hemichionaspis pseudaspidistrae*, or in small scattered groups along the margins of the leaves. Later material (Hill, 648) was collected on the fruits of the plant where it occurs in somewhat greater abundance.

Porogymnaspis angulata, sp. nov.

Puparium of female (fig. 4, *a*, *b*, *c*) consisting of the naked nymphal pellicle, with (*c*) or without (*b*) a superimposed larval pellicle; yellow or orange yellow, with a broad transverse blackish or brownish fascia just behind the middle; oval, the posterior extremity slightly constricted and produced. In profile (*a*) the dorsum is seen to be medially depressed and roundly swollen on the area covered by the dark fascia. Posterior margin (fig. 4, *d*) with six prominent lanceolate (or obscurely hastate) lobes and a fringe of ligulate squames. There are three conspicuous semilunar marginal pores on each side, situated in shallow recesses. Length 0·55 mm.

Puparium of male not observed.

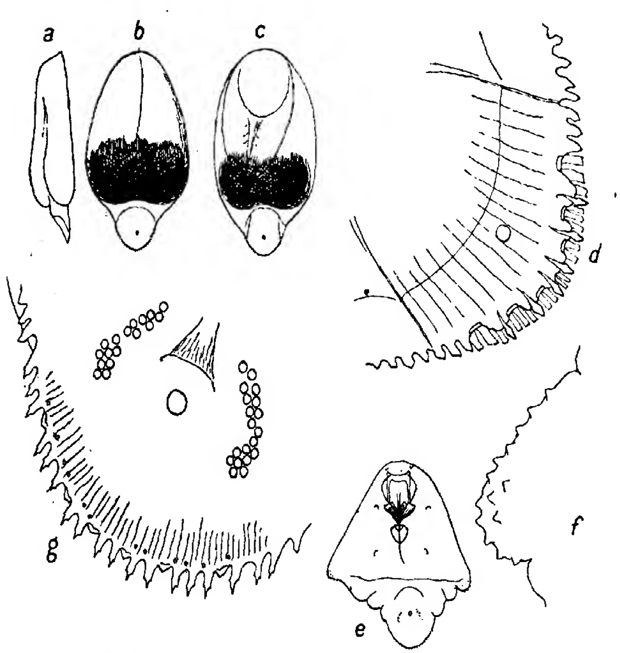

Fig. 4. *Porogymnaspis angulata*, sp. nov.; *a*, female puparium, in profile, × 60; *b*, the same, dorsal view, × 60; *c*, the same, with larval pellicle, × 60; *d*, posterior extremity of nymphal pellicle, × 280; *e*, adult female, × 80; *f*, lateral angle of female, × 450; *g*, pygidium of adult female, × 450.

Adult female (fig. 4, *e*) minute; hinder margin of thorax strongly produced on each side into a lateral angle which is studded with minute conical points (fig. 4, *f*). Pygidium (fig. 4, *g*) with two groups of from 17 to 21 circumgenital pores, connected (in some individuals) by a series of three or four isolated pores; the larger lateral groups occasionally subdivided into two on each side. Margin with six minute broadly triangular lobes and a fringe of prominent tricuspid processes, the median cusp of each produced into a sharp point. Length averaging 0·36 mm.

A still smaller and less conspicuous species than the last. On *Pandanus odoratissimus*, Koolpiniyah, N.T. (Hill, 13), and Darwin, N.T. (Hill, 636). Associated, in the former case, with *Hemichionaspis pseudaspidistrae*, and in the latter with *Aspidiotus destructor*.

Chionaspis dilatata, Green.

On *Pandanus odoratissimus*, Koolpinyah, N.T. (Hill, 14, 15).

Chionaspis graminis, Green, var. near *divergens*.

On grasses, Darwin, N.T. (Hill, 433).

Differs from the Ceylon form in the narrower and more pointed pygidium.

Hemichionaspis minor, Mask.

On *Grevillea heliosperma* (Hill, 20), and on Sisal Hemp (Hill, 21), Darwin, N.T.

Hemichionaspis pseudaspidistrae, sp. nov.

Puparium of female either translucent brownish ochreous or opaque white. These two forms are quite distinct and do not grade into each other. Large groups of each colour may occur in close juxtaposition on the same leaf, without actually intermingling. Resembling, in colour and form, the puparia of *H. aspidistrae* and *H. minor* respectively. Pellicles pale stramineous. Length 1·75 to 2 mm.

Male puparium white, strongly tricarinate. Length 1 mm.

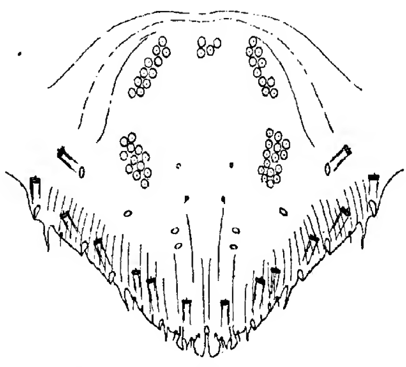

Fig. 5. *Hemichionaspis pseudaspidistrae*, sp. n.; pygidium of adult ♀, × 280.

Adult female very similar to that of *H. aspidistrae*. Margins of abdominal segments moderately produced. Pygidium (fig. 5) with prominent median lobes which are distinctly separate or even slightly divergent, and indented at two points on the outer margin; lateral lobe single, slender, dolabriform. Circumgenital glands in five groups: median with from 2 to 4 pores, upper laterals 8 to 13, lower laterals 8 to 15, averaging 4·10 and 12 respectively. Dorsal oval pores few. Length averaging 0·75 mm.

On *Pandanus odoratissimus*, Koolpiniyah, N.T. (Hill, 13, 14, 15).

The strongly marked separation of the median lobes is a distinguishing character of this species. In this respect it resembles *Pinnaspis siphonodontis* of Cockerell, but differs from that insect in the lateral lobe being single instead of duplex.

I am not sure if Prof. Cockerell has adopted the name *Pinnaspis* to cover the numerous species at present placed under *Hemichionaspis*, but if so, I am of opinion that he is fully justified in such a course. *Pinnaspis buxi* (the type of the genus) is clearly congeneric with *Hemichionaspis aspidistrae*.

The segregation of the two forms of puparia (ochreous and white) is quite remarkable. They are sometimes massed in large clearly defined patches that actually adjoin each other without commingling. Such a marked differentiation led me to doubt my original determinations, but repeated preparations have invariably shown the same results—complete identity of the insects.

Lepidosaphes incisor, sp. nov.

Puparium of female pale brown or brownish ochreous, semi-translucent; larval pellicle paler. Pointed in front, widening gradually to near the posterior extremity where it is broadly rounded. Median area moderately convex. Margins of hinder parts broadly flattened. Average length 2·5 mm.

Puparium of male similar, but smaller and relatively narrower; margins not flattened. Length 1·5 mm.

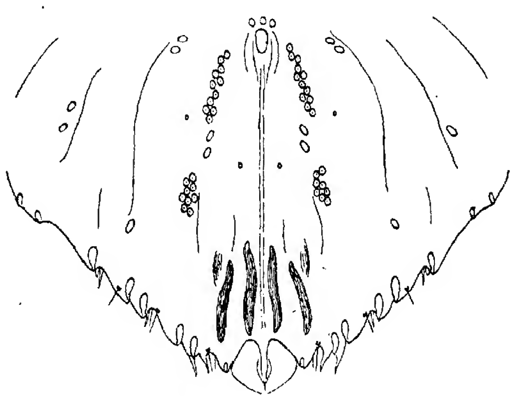

Fig. 6. *Lepidosaphes incisor*, sp. n.; pygidium of adult ♀, × 280.

Adult female elongate, narrowed in front, broadest across the median abdominal segments. Margins of abdominal segments strongly produced, especially in parasitized examples. Anterior spiracles with two or three parastigmatic pores; posterior spiracles without pores. Pygidium (fig. 6) with a single median pair of large prominent triangular lobes, closely approximated and set at an angle so that their apices meet like a pair of pincers. Margin of pygidium with a series of small prominences, each bearing a conspicuous oval pore. Tubular squames few and inconspicuous, often more or less obsolescent. Anal orifice of moderate size, near the base of the pygidium. Four elongate thickenings of the derm run inwards from

a point just above the median lobes. Circumgenital glands in five groups: median group 3 to 5 (average 4), upper laterals 7 to 12 (average 10), lower laterals 8 to 12 (average 8). Dorsal oval pores very few on the pygidium; groups of smaller pores on lateral margins of abdominal and metathoracic segments. Length 1 to 1·5 mm.

On foliage of *Melaleuca leucadendron*, Koolpiniyah, N.T. (Hill, 18), and Stapleton, N.T. (Hill, 88).

The only other Diaspid that has median lobes of a form at all resembling those of this insect is *Aspidiotus acaciae*.

Lepidosaphes hemichionaspiformis, sp. nov.

Puparium of female (fig. 7, *d*) translucent white, pellicles pale stramineous; elongate, narrow; lateral margins flattened. Average length 2 mm.

Male puparium (fig. 7, *c*) similar but smaller; without flattened margin. Length approximately 1 mm.

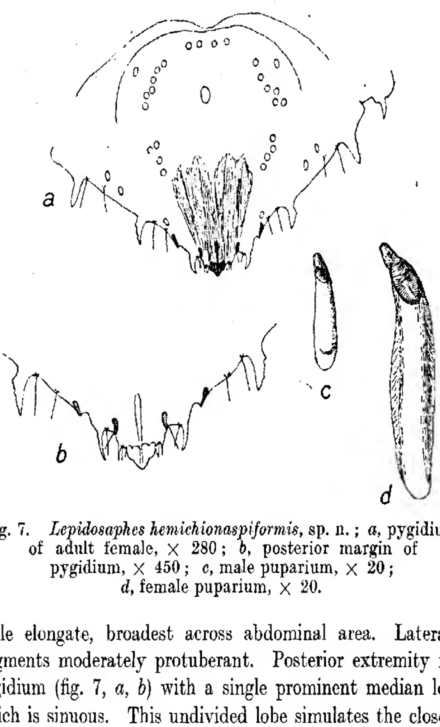

Fig. 7. *Lepidosaphes hemichionaspiformis*, sp. n.; *a*, pygidium of adult female, × 280; *b*, posterior margin of pygidium, × 450; *c*, male puparium, × 20; *d*, female puparium, × 20.

Adult female elongate, broadest across abdominal area. Lateral margins of abdominal segments moderately protuberant. Posterior extremity rather acutely pointed. Pygidium (fig. 7, *a*, *b*) with a single prominent median lobe, the outer margin of which is sinuous. This undivided lobe simulates the closely contiguous median lobes of certain species of *Hemichionaspis*. A small but conspicuous paraphysis on each side, near the extremity, and a densely chitinous cuneiform ingrowth from a small prominence at a short distance further up the margin. What appears to correspond with the usual tubular squames are—in this species—flattened;

four on each side, the one nearest the extremity minute and spiniform, the two nearest the base broadly expanded and externally sinuate. Dorsal oval pores few. Circumgenital glands in five groups, the number of pores unusually constant, median group 4, upper laterals 6, lower laterals 4. Length 0·75 mm.

On *Melaleuca leucadendron*, Stapleton, N.T. (Hill, 635). Heavily attacked by a red parasitic fungus.

In the peculiar structure of the pygidial margin, this insect approaches *Chionaspis cinnamomi*, mihi; but in that species the median lobes, though closely approximated, are distinctly divided, and *cinnamomi* is without circumgenital glands.

Leucaspis japonica var. *darwiniensis*, nov.

Female puparium dull brown, thinly overlaid with whitish secretion.

Male puparium white; rather convex, not carinated.

Nymphal pellicle (fig. 8, *a*) coarsely granulose. Posterior extremity (fig. 8, *b*) with four sharply tricuspid lobes. Length 1 to 1·15 mm.

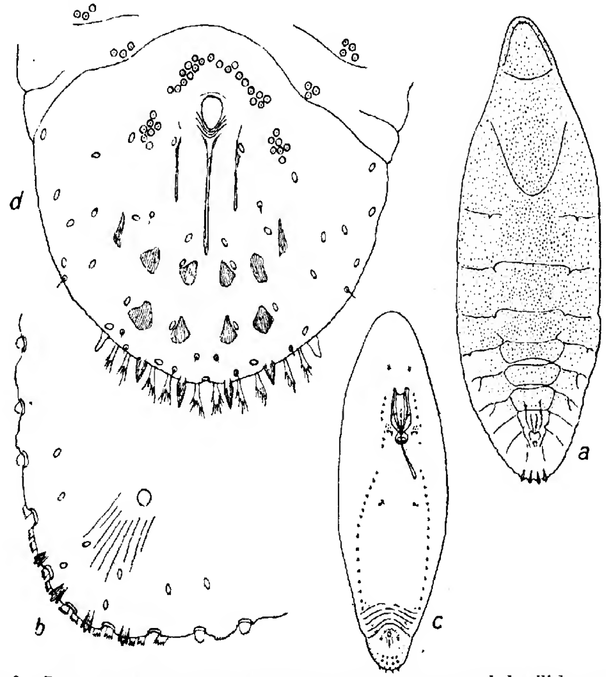

Fig. 8. *Leucaspis japonica* var. *darwiniensis*, var. n.; *a*, nymphal pellicle, × 65; *b*, posterior extremity of nymph, × 280; *c*, adult female, × 65; *d*, pygidium of female, × 450.

Adult female (fig. 8, *c*) slender before gestation; later contracted and proportionately broader. Two sinuous longitudinal series of minute conical points on the venter, embracing the rostrum and extending downwards to near the base of the pygidium. Anterior spiracles with a small group of four or five parastigmatic pores.

Pygidium (fig. 8, *d*) rounded, with four acutely pointed prominent lobes, of which the median pair are lanceolate and the laterals conical. Squames long and deeply fimbriate. There is a very delicate prominent pointed process immediately beyond the outermost squame, on each side, which is obsolescent in older examples. Circumgenital glands in three groups: median group 20 to 25, laterals 7 to 8; small supplementary groups (of 3 or 4 pores) on each of the two preceding segments. Oval dorsal pores numerous, scattered. There are two transverse series of irregularly quadrate or triangular thickened patches across the hinder half of the pygidium. Length of extended insect 0·75 to 0·85 mm.; after gestation 0·5 mm.

On foliage of *Ficus orbicularis*, Darwin, N.T. (Hill, 23, 25).

Differs from the type in its smaller size. Nymphal pellicle more strongly granulose: its pygidial lobes more deeply cleft. The ventral series of conical points more extended. Posterior margin of adult female with longer and more deeply fimbriate squames.

Fiorinia acaciae, Mask.

On *Acacia* sp., Darwin, N.T. (Hill, 634).

This appears to be a remarkably variable insect, as may be seen by reference to the figures (fig. 9, *a–h*), which represent variations of the posterior margin of the adult female. The figures are all drawn to the same scale (magnified 450 diameters).

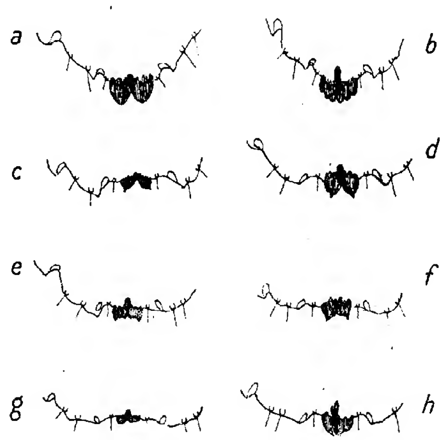

Fig. 9. *Fiorinia acaciae*, Mask.; *a–h*, various forms of median lobes on pygidium of adult ♀, × 450.

Extreme forms might be mistaken for distinct species, but intermediate forms occur, often in the same gathering. Forms *a*, *e*, and *h*, for instance, all occur in a small gathering from Somerville, Victoria. Maskell, in his diagnosis of the species, describes "a single median floriated lobe." I have seen no examples in which the lobes are actually united, except an aberrant and asymmetrical specimen shown at *h*. In the form *b*, which otherwise answers closely to Maskell's description, there is a distinct

median division, though the lobes are closely approximated. Leonardi (" Saggio di Sistematica delle Fioriniae ") figures a form that is nearer to my figure *a*. Fuller (" Notes and Descriptions of some Species of Western Australian Coccidae ") describes—as *F. acaciae* var. *biloba*—a form with " two lobes, closely adjacent and at first sight appearing as one semi-circular lobe." In some examples the lobes are widely divergent (see fig. 9, *c*). In others (*g*) they are small and almost obsolescent.

Lecanium nigrum, Nietn.

Darwin, N.T. (Hill, 565); food-plant not stated.

Pulvinaria psidii, Mask.

Darwin, N.T. (Hill, 507); food-plant not stated.

Asterolecanium hilli, sp. nov.

Puparium of female yellow. Elongate, slightly convex above, bluntly pointed at posterior extremity, with a slight median longitudinal carina which is obsolescent in some examples. Marginal fringe short and inconspicuous, often fragmentary. Average length 2 mm. Breadth 0·75 mm.

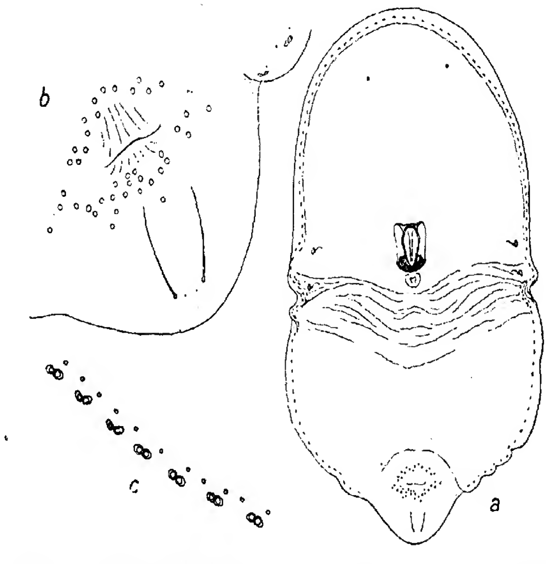

Fig. 10. *Asterolecanium hilli*, sp. n.; *a*, adult female, × 80; *b*, posterior extremity, × 280; *c*, marginal pores, × 500.

Adult female at first elongate, the posterior extremity bluntly pointed; afterwards the body becomes greatly contracted and transversely wrinkled across the base of the abdomen (fig. 10, *a*). Frons strongly produced in front of the rostrum, which, in the later stages, assumes a central position, the rudimentary antennae remaining near the anterior extremity. Spiracles placed close to the margin.

Marginal paired pores (fig. 10, *c*) in a single row, rather small and inconspicuous, discontinued at the base of the posterior segment, which is pygidiform (fig. 10, *b*). Genital orifice surrounded by circular ceriferous pores. Caudal setae folded back upon the venter. No trace of anal lobes or of a setiferous ring. After examination of many preparations, I have been unable to locate the position of the anal orifice.

On foliage of a palm (*Livistona humilis*), Stapleton, N.T. (Hill, 640).

Distinguishable from any other known species by the peculiar characters of the posterior segment.

? Sphaerococcus diaspidiformis, sp. nov.

Puparium of female (fig. 11, *a*, *b*, *c*) circular, convex above, with a central raised boss. Texture firm and hard, of a horny consistency, resisting the action of boiling potash. Surface coarsely granulate and corrugate. Colour yellowish, the central

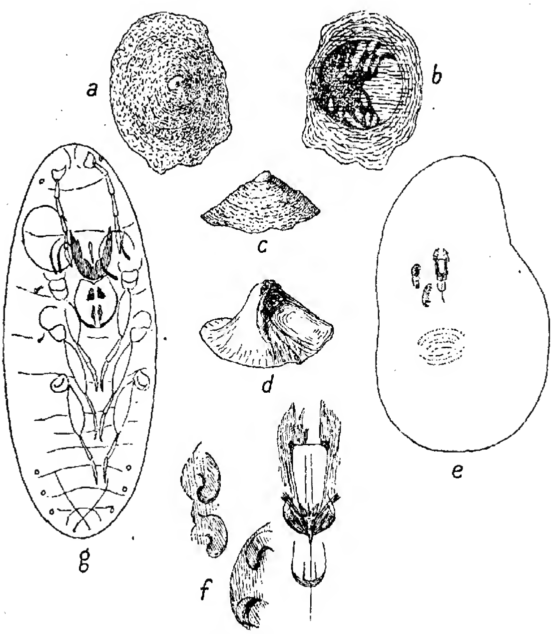

Fig. 11. *Sphaerococcus diaspidiformis*, sp. n.; *a*, puparium, from above, ×20; *b*, puparium, from below, ×20; *c*, puparium, side view, × 20; *d*, adult female, side view, × 33; *e*, adult female, after maceration, × 65; *f*, rostrum and spiracles, × 280; *g*, embryonic larva, × 280.

boss clear and translucent. Exuviae not included in the substance of the puparium. Under surface flat, with a thin translucent pellicle revealing the form of the insect within (fig. 11, *b*). Diameter 1·1 mm.

The female lies loose within the puparium, but is difficult to extract entire. Its removal can be effected only by gradually breaking away the upper part of the

puparium. When extracted it is seen to be of the form shown in figure 11, *d*. The median dorsal area rises into a central hump, on the summit of which are grouped the four spiracles which—in this insect—have taken up a dorsal position. Immediately behind the central prominence the body is abruptly depressed, transversely folded for a short distance, and encloses a large circumscribed flattened or slightly concave area extending to the posterior margin. Colour of dried insect reddish brown, marbled with pale spaces; the flattened posterior area colourless and translucent. After maceration and preparation for microscopical study, the insect displays a remarkable lack of characters (see fig. 11, *e*); the derm appears to be devoid of ceriferous pores, and no rudiments of antennae are to be seen. The only conspicuous features are the mouth-parts and the spiracles. Some faint concentric lines near the centre indicate what I take to be the genital orifice, but I have been unable to locate any anal aperture. The actual position of the spiracles is upon the summit of the dorsal prominence, but under compression they become displaced and usually appear together on one side of the rostrum. The genital orifice also appears to have assumed a dorsal position—amongst the folds at the base of the posterior depressed area. The characters of the rostrum and spiracles are shown in figure 11, *f*. Each pair of spiracles is partially surrounded by an ill-defined denser area. Length of adult female (under compression) 0·5 to 0·75 mm.

The body of the insect usually contains several well-developed embryos, one of which is shown—greatly enlarged—in figure 11, *g*. Three conspicuous circular pores are noticeable on each side, near the posterior extremity. A pair of caudal setae is folded back upon the venter. Other stages not observed.

On leaf-stalks of a palm (*Livistona humilis*), Stapleton, N.T. (Hill, 640).

Altogether a very anomalous insect. I have placed it provisionally in the genus *Sphaerococcus*, but its ultimate position must remain problematical until the earlier stages are available for study. The absence of any dermal glands or pores suggests the probability that the puparium is constructed during the nymphal stage.

REPORT ON THE INVESTIGATION INTO THE BIONOMICS OF GLOSSINA MORSITANS IN NORTHERN RHODESIA, 1915.

By Ll. Lloyd,

Chief Entomologist in Northern Rhodesia.

(Plate I.)

The following report deals with the investigation into the bionomics of *Glossina morsitans* being carried out in Northern Rhodesia on behalf of the British South Africa Company.

On my return from leave in July 1914 it was decided to form a base camp close to the railway line. Several areas in the neighbourhood of Broken Hill where fly was reported as being very thick were first examined, but were found from various causes to be unsuitable. A site was finally selected at the source of the Lukanga River, about four miles from the line and near Kashitu station, midway between Broken Hill and Ndola. Building was commenced in August and completed in October, just before the commencement of the rains.

Messrs. Eminson and Dollman, who had been working on the Kafue River at Mwengwa, had just reported the discovery of *Mutilla glossinae*, Turner, a wasp parasitic on the pupae of *G. morsitans* and of considerable importance, since the former worker found that about 10 per cent. of the 350 pupae he had collected were destroyed by this insect. This is the first insect parasite of any tsetse to be found in numbers, and it was decided to let the future investigations centralise round it. In order to discover whether it was localised or generally distributed, a tour was made through the fly areas of N.E. Rhodesia during the dry season of last year (1915) for the collection of pupae in various localities. About 4,000 were collected and examined. May and July were spent at Chutika (Hargreaves) in the Luangwa Valley, part of August at Nawalia in the Mpika section of the same valley, and September at Ngoa on the plateau near Mpika. Breeding was found to have commenced in the Luangwa Valley about the middle of April, and by the time the plateau was reached it was at its height. Before dealing with the parasites found, some general questions will be discussed.

Density of Fly in relation to Game.

Kashitu is representative of those fly areas in which, though game is relatively scarce, fly appears to be very numerous and troublesome. It is not however an extreme case, such as the immediate neighbourhood of Broken Hill. In the Kashitu area game is not particularly uncommon, but the animals, with the exception of one or two herds of sable, are very restless and do not return to the same spots day after day to feed. The consequence is that the fly is very hungry and both sexes swarm round any person passing through and are all eager to feed. This eagerness to feed gives one at first a false impression of the numbers of fly in the area compared

with fly areas in which game is numerous and little disturbed. Table I. has been constructed to illustrate this point. In it are compared the catches made by fly boys in three areas, in two of which, Nawalia and Ngoa, game is very plentiful, while in the third, Kashitu, it is much less so. The periods do not correspond, but this does not affect the figures to any great extent. The numbers caught and the proportion of the sexes varies more from day to day than over long periods at different seasons of the year. It will be seen that at Kashitu female flies were three times as easy to obtain as at Nawalia, and twice as easy as at Ngoa, while males were twice as easily obtained at Nawalia as at Kashitu. The percentage of females in the total catch is three times as great at Kashitu as at Nawalia. Occasionally the females in a day's catch at Kashitu were slightly in excess of the males. The number of male flies caught is more indicative of the amount of fly in an area than is the number of female flies, since the males follow moving animals whether hungry or not, in search of mates.

TABLE I.

Comparing the Catches of Fly in relation to the Amount of Game in an Area.

Locality.	Game.	Period.	No. of catches.	Total ♀ flies.	Total ♂ flies.	No. per net per day.		Percentage of ♀ flies.
						♀	♂	
Nawalia ..	Very plentiful	Sept. to Dec.	46	727	4849	3·2	21·0	13·0%
Ngoa ..	Very plentiful	Dec. to July	79	1315	—	4·2	—	—
Kashitu ..	Not plentiful	Oct. to March	41	1219	1722	7·9	10·5	41·5%

The pupa collecting also shows that the fly is less numerous than it appears to be in the areas where game is scanty. Table II. shows the relative frequency with which pupae are found in two of the areas considered above and at Chutika, another locality where game is numerous. Empty puparia are included with the pupae to make the figures more representative by obviating the influence of the seasons in which the searches were made, so far as possible. This makes the proportion at Chutika lower than it should be, because the breeding places there were mainly positions that would be submerged during the rains, the puparia being washed away. Ngoa and Kashitu may be quite fairly compared, since the conditions in the two districts are the same. It will be seen that a native in a day's work was able to obtain four times as many at Ngoa as at Kashitu. The restlessness of the game may account for this to some extent, but it is obvious that the pupae, and therefore the flies, are fewer in the area where the game is less plentiful. In each case the country covered was about five miles in each direction from the central camp, and the same five natives have been employed throughout. They were already thoroughly experienced before working the Kashitu area.

TABLE II.

Comparing the Collection of Pupae in relation to the Amount of Game in an Area.

Locality.	Game.	Period.	No. of collections.	No. of pupae and empty cases found.	No. per collector per day.
Ngoa ..	Very plentiful	Jan. to Sept.	48	7485	31
Chutika ..	Very plentiful	May and July	27	2016	18
Kashitu ..	Not plentiful	Oct. and Nov.	26	934	7

A similar condition of things as regards the game, the pupae, and the hunger of the fly was found at Ngoa in the various areas in which pupae were collected. These will be briefly described.

(1). A forest area bordered by the Kalamba Stream, and previously described in detail (Bull. Ent. Res., v, 1914, p. 57). It was usually very attractive to game owing to the mud wallows in the stream bed. This year the stream was dry and the grass unburnt, and there was no particular attraction to game, though animals passed through fairly frequently. Fly was troublesome and it was not unusual to be bitten thirty or forty times during the morning. Five days' work yielded 259 pupae and 677 cases. Pupae were much more freely found about the same time of year in 1913 when the stream was flowing and game, especially rhinoceros, moving regularly there.

(2). This area is also part of that previously described. It is bordered by a swamp and narrow vlei and contains salt-licks. The grass had been burnt off a fortnight before the work was commenced, and the fire had passed right across the swamp, burning the reeds down to the roots. A new growth had sprung up at once and this made the spot very attractive to game. A herd of about twenty roan were feeding regularly on the swamp and were spending the middle of the day in this area and the one next to be discussed. Zebra and eland had also been feeding there. As the camp was in this area the animals left after a few days. During the month spent at this place the fly became increasingly troublesome as the game moved away. In four days' work 344 pupae and 409 cases were taken; a much heavier yield than in 1913, when part of the area was avoided by the game owing to the presence of our permanent camp.

(3). This is a little triangular area about a quarter of a square mile in extent, bounded on two sides by the vlei and burnt swamp mentioned above. I had not seen game in it previous to this occasion, with the exception of once some puku and reedbuck. It was now a regular haunt of the herd of roan. It was searched in July and August 1913 on several occasions, no pupae and only 22 empty cases being found. This year it was worked on 9th and 10th September, when 130 pupae, but only 15 empty cases, were taken. The small number of cases shows that it had not previously been a favoured breeding ground. The pupation period at this time was about

36 days, so that the period during which the pupae might have been deposited was from 5th August to 10th September. The days on which the flies emerged were noted and the dates of deposition thus calculated. It was found that six pupae had been deposited before 24th August, and 83 between this date and 10th September. (Twenty-two were broken in collecting and 21 died. The mortality was not in this case apparently due to the fires, since in series collected in unburnt country the mortality was about the same, and was due to some cause at present unknown; possibly slight damage in collecting, or some unhealthy condition in the fly tubes, e.g., dessication). Free breeding in this area therefore began about ten days after the fire had passed and the new grass in the swamp commenced to grow. In all the other series at Ngoa the deposition of the pupae had been fairly even over the possible periods between 28th July and 27th September. Fly in this area was very troublesome, but the game had been absent some days when the collection was made.

(4). Consists of the edge of a wide vlei along the Kanchibia River, and some old native gardens very near. The area had been burnt and had a good new growth of grass when examined. At all seasons this is a popular place with the game animals, which feed on the vlei and retire to the old gardens. In six collections 718 pupae and 521 cases were taken. Fly was seen in very small numbers and the workers were rarely bitten.

(5). This consists of a piece of flat country bordering a wide vlei called the Pembe. The vegetation consists of long grass and bracken with scattered trees, and in one or two places small patches of ordinary forest. The whole of the country had been burnt off a month previously and the new growth was well developed. Game is always to be found here and the whole vlei was pitted with the spoor, while deeply cut game paths ran between the more favoured spots. In four collections 989 pupae and 1,325 cases were taken. As in the previous case, very few tsetse were seen and these were not hungry. It is curious that in this and the previous case no swarms of male flies were seen. A possible explanation is that movement when collecting is very slow, only a few yards at a time with long pauses.

(6). Along the edges of an unburnt vlei which is often attractive to game, especially zebra and hartebeeste. No recent spoor was seen and the animals had doubtless left for the more attractive burnt country near. One search yielded 10 pupae (only two of which produced flies), and 71 empty cases. A great deal of fly was seen and all the workers were badly bitten.

The above facts are reproduced in Table III. The subject has been discussed in some detail because by comparing the numbers and behaviour of the fly in areas where game is plentiful and those in which it is scanty, some hints may be obtained as to what would be the result of the much desired experiment in game destruction. Half measures appear to be worse than useless. On the other hand, if the game were reduced to a minimum so that the fly is much attracted to man there might be some hope of destroying it by means of nets in very limited areas.

The reduction of game in a fly area apparently leads to the following results. The casual observer would notice no reduction at first, but might even see an increase owing to the increased hunger of the fly; the number of female flies in an indiscriminate catch would rise towards fifty per cent.—an important point if netting were used as a means of exterminating them; and pupae would be found in fewer numbers, showing that an actual reduction had taken place.

TABLE III.

Showing the Relation between Breeding, the Prevalence of Game, and the Hunger of the Fly in various Areas at Ngoa.

Area.	Note on game.	Note on Fly.	No of collections.	Total pupae taken.	Total empty cases taken.	No. of pupae per collection.	No. of empty cases per collection.
1	None resident, but passing frequently	Numerous and very hungry	5	259	677	52	135
2	Plentiful, but left at start of work	Numerous, troublesome and increasingly so	4	344	409	83	102
3	As in (2)	As in (2)	2	130	15	65	8
4	Game very plentiful	Little seen, and this not troublesome	6	708	521	118	87
5	As in (4)	As in (4)	4	989	1325	247	331
6	No game now ; often plentiful	Numerous and very troublesome	1	10	71	10	71

Destruction of pupae by bush fires.

The pupae collected were kept in wide glass tubes closed at the top by a double layer of muslin to prevent the escape of small parasites. They were protected from the heat as far as possible during the travelling by being placed in boxes wrapped in muslin, and these again in a stout wooden case lined with several layers of blotting paper. A considerable number in each series died, but the mortality was much higher in those from the areas over which the fires had passed at Ngoa.

Chutika	1164 pupae	18% mortality.	
Nawalia	155 ,,	10% ,,	
Ngoa, area (1) unburnt ..	259 ,,	17% ,,	
,, ,, (2) burnt ..	344 ,,	29% ,,	
,, ,, (4) ,, ..	708 ,,	30% ,,	
,, ,, (5) ,, ..	989 ,,	28% ,,	

From these figures it is seen that in the burnt areas about 12 per cent. were dead at the time they were collected, and from some cause not present in the unburnt areas. This cause was almost certainly the fire. In area (4), which included old gardens, 170 pupae were taken from under the remains of the fences. The fences had been largely burnt and the pupae were taken under the small stretches that remained, being in many cases dug up from amongst the ash. It is obvious that any pupae in such positions would be killed by the fire. No accurate estimate of the proportion that are destroyed by this means can be gathered from these figures, since the collections were made too long after the burning. A series collected immediately after a bush fire would probably give interesting results.

Breeding Places.

Enough has been said to show that the flies breed most freely in spots to which the game is most attracted. Up to the present 700 breeding places have been examined, and all agree in the one respect, that over or very close to each is some relatively dark hiding place for the flies. These places have been found in all types of country wherever they have been looked for in fly areas, with the exception of a stretch of thin mopani forest close to Nawalia. A day was spent in searching this piece of country in the height of the breeding season. Fly was fairly numerous and game paths ran in every direction, but only two empty and old cases were found. No explanation can be given of this, as pupae were taken very freely in a similar piece of mopani bush near Chutika. An area of long grass country near Chutika yielded few pupae, but on a closely similar stretch near Ngoa many were found.

Two or three of the positions will be discussed, as they differ from any that have previously been described, and they show that it is improbable that any special odour, such as that of humus, attracts the pregnant flies.

(1). Under overhanging rocks in a vlei near the Lukanga River, Kashitu, ten empty cases were taken. The hollows under the rocks were deep and dark, without vegetation. The spot was an occasional haunt of reedbuck.

(2). Chutika, in the thin mopani forest. A little hollow in the ground about two feet long, one broad and one deep, forming the commencement of a flood stream bed. The bottom was of pebbles, and the sides were of alluvial clay and much creviced,

giving hiding places to the flies. The hollow was partly filled with dead leaves, and 11 pupae and three empty cases were taken. Pupae were taken in ten similar positions. Since the flies breed in these places, it is only reasonable to suppose that they also breed in the fissures in the earth which are so plentiful in the Luangwa Valley. In the dry season the swampy ground dries and cracks in every direction. The cracks run several feet into the ground and are very extensive. The ground is baked like Kimberley brick and the investigation of them would be practically impossible without the use of dynamite.

(3). Chutika, in the bed of the Bwobwa stream, a sandy gully running through thick bush. This is a permanent stream during the rains, and at the time of search (July) still contained pools of water. At the point under consideration there were steep rocky falls about twenty feet high, with a small pool at the foot. Beyond this was a stretch of firm sand on which man's footsteps made no mark, but which was pitted by the hoofs of antelope and pig, the sand in the hoofmarks being soft. The banks were steep and overhanging with many outgrowing roots and trunks, lower down being of smooth clay, merging into the sand. The bed at this point was about 15 feet wide, and kept this character for about 15 yards from the base of the rocks to where the banks shelved out. Pupae were found in the hoofmarks only, right across the stream bed, from the point where the banks became steep nearly up to the water-hole, but not where the sand was damp. It is assumed that the larvae had been dropped from the overhanging banks and had crept on in search of a place to burrow till they came to one of the hoofmarks. In this stretch of about twelve yards of sand 275 pupae and 72 cases were taken one morning, and the following day a further 40 pupae and 19 cases. Among the rocks above the falls 14 pupae and 11 cases were found. In a stretch of fifty yards of sand with overhanging banks above the rocks 388 pupae and 99 cases were taken. Less than a hundred yards of this stream bed thus yielded 717 pupae and 92 cases in three mornings.

All the pupae taken at Nawalia were from a similar position (Plate i, fig. 1), but in this case the sand was soft, the pupae were near the surface, and about nine inches down the sand was wet. After good rains this stream flows practically right through the dry season. Over about a hundred yards 155 pupae and 33 cases were taken. The similarity of these breeding spots to those of *G. palpalis* will be noted.

Parasites.

Six species of insect parasites of the pupae have been met with, and these have been identified by the Imperial Bureau of Entomology.

Hymenoptera.

(1). *Mutilla glossinae*, Turner,* is the parasite most generally distributed. It was first recorded by Eminson at Mwengwa in N.W. Rhodesia, and later by Dollman at Namaula, a village near Mwengwa. The early part of the life-history is not yet known. The larva when full grown has completely eaten the pupa of the tsetse-fly and the puparium is left in a very weak condition, readily broken in collecting. It is a white stout maggot-like insect, about 5 mm. in length and slightly curved (fig. 1, *a*). The spiracles are extremely small and difficult to see, there being apparently eleven

* Bull. Ent. Res., v, pp. 381–383.

pairs. The head, seen in front view, has the appearance of a five-petalled rosette. The mandibles are well developed and carry four sharp interdigitating teeth. The antennae and maxillary palpi are short and stumpy and surrounded by oval chitinised ridges. Between and below the palpi is a small depression, which may be the pore of the silk gland. The internal chitinous supports of the mandibles can be seen through the skin and complete the rosette appearance (fig. 1, *b*).

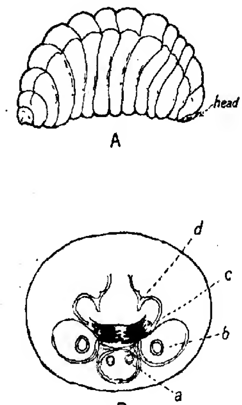

Fig. 1. Larva of *Mutilla glossinae*, Turner; A, lateral view, × 10; B, front view of head, × 60: (*a*) palpi, (*b*) antennae, (*c*) mandibles, (*d*) internal chitinous supports.

When full grown the larva spins a very strong papery cocoon, and when this is complete, it is apparently independent of the tsetse puparium, which is indeed occasionally split in the act of spinning or by the drying of the silk. The puparium often shales away from the cocoon in places when collected, but the *Mutilla* is not affected by this. The cocoon is yellow or pale brown in colour and mottled with dark patches of faecal matter. The pupa, as is usual in Hymenoptera, takes on gradually the colours of the adult. In one case in which the cocoon was slightly opened the larva pupated on 5th August, and the imago emerged on 19th September, giving a pupation period of 45 days. The mature insect bites a round hole in the cocoon and puparium for emergence, usually, but not always, at the anterior end. In one case the insect emerged at the posterior end.

The adults live well in captivity. As a larger species of *Mutilla* was once observed eating jam, this article was used as a diet and answered well, both sexes feeding eagerly upon it. A small smear was placed on a piece of cork in the vessel in which the insects were kept. Mating took place freely and repeatedly. The females lived for about three weeks and the males for from ten days to a fortnight. An attempt to breed them was unsuccessful. No tsetse larvae could be obtained, as the breeding of these is impractible while travelling.

M. glossinae is generally distributed in *morsitans* areas in N. Rhodesia. It has been found wherever searches have been made for it, the localities being Mwengwa on the

Kafue R., Chutika and Nawalia on the Luangwa, and Ngoa and Kashitu on the high plateau. This gives an east to west range of over 400 miles, and a north to south range of over 200 miles. The percentage of infection is sometimes heavy.

At Chutika the *Mutilla* was obtained in 80 cases from 1,164 pupae (7 per cent.). Of these 76 were collected in a stretch of mopani forest among 477 pupae (16 per cent.), and 4 from a sandy stream bed among 717 pupae (·5 per cent.). They were collected during July and the insects emerged between 15th August and 6th October; 61 of them during September. Eleven of them were badly damaged in collecting or were killed for examination in early stages. The remaining 69 produced 46 females and 23 males. The latter sex appears to be dimorphic, 10 of them having the thorax entirely black, and 13 with the dorsal surface red, as in males at Mwengwa. At Nawalia the males have the thorax black and at Ngoa dorsally red. No other differences were found, but a final opinion is not expressed as to whether they are all of one species.

At Nawalia from 155 pupae collected in a sandy stream bed 20 (13 per cent.) parasites were obtained, a quarter of them being males. These were collected on 21st and 23rd August, and the insects emerged between 25th September and 26th October.

At Ngoa 14 were obtained from 2,500 pupae, collected in September, the insects emerging between 28th September and 12th October. The parasite was very localised here, only being found in one small area. Nine of them were taken on 4th September among a total of 32 pupae, the others being taken subsequently within half a mile of the same place. A few of the old cocoons were also seen in this locality, but over the rest of the Ngoa area none could be found in some 4,000 empty cases examined.

At Kashitu, up to December 1915, two females have emerged and a number of the characteristic cocoons have been seen.

(2). *Anastatus viridiceps*, Wtrst., was first met with by the writer at Kashitu in November 1914. In the present year it has been taken four times in the same locality, but has been seen nowhere else. Pupa-cases from which a Chalcid of about the same size had emerged were taken, however, at both Chutika and Ngoa. In each case 15 of the insects emerged from the puparium, the largest number of males emerging being six, and the lowest two. Fertilisation took place readily, but the attempt to breed the insect failed. Fertilised females were exposed in beakers to four newly deposited pupae and to eight larvae, the heavily pregnant tsetse being enclosed in the vessels and larvipositing there. The pupae all produced perfect flies.

(3). *Stomatoceras micans*, Wtrst., a large species first met with by Eminson at Mwengwa, was taken on two occasions at Ngoa in September. In each case a single female emerged. The entire contents of the tsetse puparia are not devoured, in one case the débris being an unrecognisable mass and in the other an almost fully developed fly.

(4). *Syntomosphyrum glossinae*, Wtrst., a very small species, also taken by Eminson at Mwengwa, was met with eight times at Ngoa and five times at Kashitu. It was not seen in the Luangwa Valley, but probably occurs there, as six empty puparia bored by the tiny hole which this species makes were found. The numbers

which emerged from the puparia varied very much, the highest being 53, but the usual number appears to be about 25. The insect was taken from September to November.

Diptera.

Two species of BOMBYLIIDAE were met with at Chutika and Ngoa respectively. A parasitic larva (fig. 2, *a*) has also been taken at Kashitu and at Ngoa, which is almost certainly that of a Bombyliid. When the larva has eaten up the entire contents of the puparium, this is left in a very fragile condition and is very readily broken in collecting. This larva is a white stout curved maggot, amphipneustic, and with a very small head. The mandibles resemble a pair of scissors with the points directed downwards, each bearing a tubercle on its outer surface, the edges working together but not crossing (fig. 2, *b*). The antennae and palps are small, inconspicuous and nipple-like. This larva has been seen four times at Kashitu and once at Ngoa. Though undamaged, in two cases they did not pupate. One lived for two months, moving slightly occasionally.

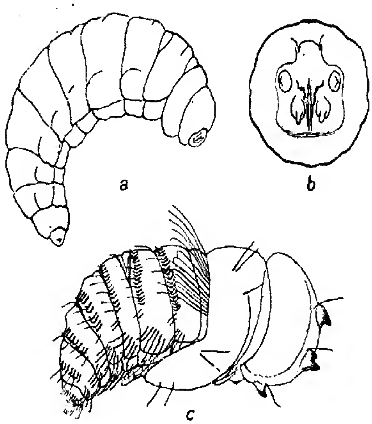

Fig. 2. Early stages of *Villa lloydi*, Aust., parasitic on *Glossina morsitans*; *a*, larva; *b*, front view of head of larva; *c*, pupa.

The pupa (fig. 2, *c*) has a rounded head armed with three pairs of strongly chitinised tubercles. The first segment of the abdomen bears dorsally a fringe of long stiff hairs directed backwards, these being replaced on the remaining segments by short recurved hooks, with a few hairs. The third pair of legs protrude as stout pegs. The pupa bursts out of the tsetse puparium anteriorly and works its way up to the surface of the ground by means of the long fringe of hairs, which are alternately raised and depressed, the peg-like legs acting as a fulcrum. On the surface it becomes quiescent, elongates, splits along the dorsal surface, and the fly emerges, being ready for flight almost at once. The time from the cessation of movement of the pupa to the flight of the fly occupies only two or three minutes.

The two species met with are as follows :—

(1). This species, taken at Ngoa, is apparently identical with *Villa lloydi*, Aust., which was taken in the same locality in 1913. Three specimens of the perfect insect were obtained on this occasion, and its pupa was taken three times in puparia broken in collecting. The pupae were collected in September and the flies emerged in the same month. The pupa figured belongs to this species.

(2). The second species was taken at Chutika in July, the flies emerging during August. Only two were obtained. It is readily distinguished from the foregoing by the extensive black markings on the wings at the base and along the costal border, and by two conspicuous bands of white hair on the dorsal side of the abdomen. The pupa also is quite distinct, the head tubercles being blunt and conical, whereas in *V. lloydi* they are sharp teeth.*

Glossina morsitans feeding on a Bird.

Nucleated red cells have been found with tolerable frequency in *G. morsitans*, but up to the present no case has been recorded in which it has been seen feeding on birds in nature. At the Kashitu camp there was in captivity for a few days a young specimen of the ground hornbill, about the size of a turkey. It used to walk about the camp without restraint and on two occasions tsetse were seen settled upon it. In one case there were two flies upon the bare skin of the neck, and one was actually feeding at the time. This bird is a common one, living gregariously in flocks of sometimes twenty or more individuals. They feed on insects, lizards and frogs, and are frequently to be seen on the vleis and resting in the trees along the edges. They are very shy, and the difficulty of approaching within a hundred yards of them makes close observation in nature hardly possible.

Glossina morsitans feeding on Serous Fluid.

In a series of experiments connected with trypanosome transmission at Kashitu wild flies were being fed on rabbits. The hair was cut short along the belly, and the flies were being fed in the usual way. On three occasions the flies gorged themselves with clear fluid instead of with blood. The crop was greatly distended by the fluid, which was slowly ingested in the same manner as blood, the crop being empty on the second day after the meal. It is thought that the proboscids of the flies had pierced the body wall and the serous fluid was thus obtained. The observation is less of importance than of interest to the laboratory worker. The behaviour of trypanosomes injected into the abdominal cavity is different in some cases from that when they are injected into the blood stream.

A Breeding Haunt of Glossina brevipalpis.

While searches were being made for the pupae of *G. morsitans* near Chutika, in the Luangwa Valley, a single pupa of *G. brevipalpis* was found amongst them. It was collected on 28th July, and the fly emerged the following day. The pupa was found in the sandy bed of the Bwobwa Stream, which contained no running water at the time. The banks are very heavily wooded and the stream bed shady. The pupa

*[Judging by the description, this species will probably prove to be *Thyridanthrax abruptus*, Lw.—Ed.]

was buried in the sand under a large fallen tree, and 36 pupae of *G. morsitans* were taken under the same trunk. This species has been previously recorded from this locality, at the Mvuvia stream on the other bank of the Luangwa. It must however be very rare there, as the writer has only seen one other individual apart from this in three months' residence at the place.

On the Importance of Compact Villages in Fly Areas.

The cases of sleeping sickness discovered in the Luangwa Valley have been partly scattered and partly centred around certain villages :—Chinunda, Chutika, Chewanda, and Kakumbi. The first two of these being on main roads gave rise to the impression, now generally abandoned, that the disease was of recent introduction. The local nature of the epidemics also fostered the idea that man was the main, if not the only, reservoir of the trypanosome. Three of these villages with which the writer is familiar differ from the generality of the Luangwa villages in that they are shady and scattered.

Chinunda on the Rukusi River is in two parts, one on each side of the stream bed, which is deep and shady and contains running water only during, and shortly after, the rains. In such a place, it is shown elsewhere in this report, tsetse will breed if food is available. There is also in the village a fence of euphorbias which give dense shade, the tree being of a kind planted by the natives as a defence.

Chutika is in two parts, with shady trees, and the water is drawn from the Mvuvia stream, also a temporary one. This stream has to be crossed to reach the Luangwa ford to which the villagers are constantly going during the dry season for fishing and other purposes. Two of the cases at this place have been the ferry men who live in the village and go down to the canoes at a call from the opposite bank.

Kakumbi (Plate i, fig. 2) is the most interesting of the three. It is a village with huts for about 150 people, and these are scattered in small groups of four or five together, separated by groves of shady trees, a hundred yards or so apart. The photograph shows one of these groups of huts with others partly hidden behind the trees. This is a wholly exceptional type of village and is rapidly becoming depopulated by the disease. Only three miles away is a village, Kanjenjera, of the usual compact type, containing only one tree of any size. It contains about the same number of huts as Kakumbi and is still fully populated. While the mortality at Kakumbi is admitted by the natives and generally talked about, at Kanjenjera they assert that they have had no cases of the disease. At Luwewa, a village of fifteen huts, three miles beyond Kanjenjera, and six from Kakumbi, two cases were brought to the writer, and it was stated that four others had died from the disease this year. This also is a shady village. The fly is equally distributed in the bush around these three places. A camp was made in Kakumbi under one of the shady trees (a species of Ficus) in order to observe the behaviour of the fly in such a place. The village was reached at 11 a.m. and fly was seen about the tent and under the tree until night.

Each of these places where the local epidemics have occurred (Chewanda is unknown to the writer) contains the three requisites for the life of the fly, food, shade and potential breeding places, while most of the Luangwa villages lack the two last of these. Lack of shade probably accounts for the fly leaving the usual type of village.

In these shady places the natives are always liable to come into much the same relation to *G. morsitans* as are natives in *palpalis* areas to *G. palpalis*, by repeatedly passing the shady spots where the flies lurk. An infected fly brought into a village of this type or to one of the shady water-holes could easily remain long enough to infect a number of people. The writer does not believe that *G. morsitans* could ever subsist entirely on man, as it is so rarely that a fly obtains a full meal on a healthy person, European or native, but where domestic animals remain, as in the case of each village mentioned above at the time of the epidemic, the fly might be able to breed actually in this unusual type of village. At any rate the shady and scattered nature of the villages where these local epidemics have occurred seems to indicate their cause.

The epidemics could probably be avoided by allowing no shade in the villages and by making these compact. Two villages should never be allowed on opposite banks of the temporary streams, nor where stretches of shaded sand are left by the falling of the water. The clearing of the bush around water-holes in these streams however is a difficult problem, as the water would fail if the shade were removed.

Fig. 1. Shady stream bed at Nawalia where 150 pupæ of *G. morsitans* were taken; 13 % being parasitised by *Mutilla glossinæ*.

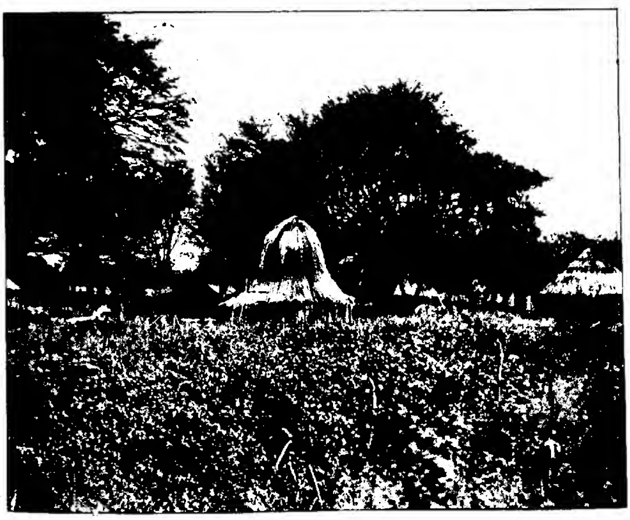

Fig. 2. A view of Kakumbi, in the Luangwa Valley, to show the shady and scattered nature of the village.

RESISTANCE OF THE EGGS OF STEGOMYIA FASCIATA (AEDES CALOPUS) TO CONDITIONS ADVERSE TO DEVELOPMENT.

By Malcolm Evan MacGregor, B.A. (Cantab.),

Wellcome Bureau of Scientific Research.

It is a well-known fact that the eggs of *Stegomyia fasciata* are highly resistant to conditions adverse to their normal development.

In April 1915 I received through the Colonial Office a few dried leaves from West Africa, on which—secured by a fine mud deposit—were eggs of this mosquito that had been in a dried condition for at least three and a half months. These were found to be viable and were successfully hatched and reared for many successive generations, as described in a recent paper.*

The eggs as they reached me showed on examination that some were normal-looking, while many were partially, and others completely, collapsed. The partially collapsed eggs no longer had the evenly rounded surface of the normal egg, but the surface presented depressions such as would result from shrinkage of the contents and the falling in of the shell. This had reached such a degree in the completely collapsed eggs that the shell on one side was in contact with that on the other, and either the egg had attained the shape of the bowl of a spoon, or had taken on the triangular form shown in section in fig. 1 (*a*).

Fig. 1. Diagram of section through collapsed eggs of *Stegomyia fasciata*; *a*, triangular form; *b*, spoon-shaped form.

When the leaves, however, were placed in water, the number of larvae that hatched out tended to convince me that at least many of the partially collapsed eggs had been viable as well as those that looked normal. This fact has led me to study the eggs that have been laid by the subsequent generations of these mosquitos with a view to finding out the powers of resistance they possess.

Soon after having established means of keeping the strain going actively, it was found that, by the methods adopted, the eggs that were laid in large numbers, and which would always hatch out vigorous larvae, were highly susceptible to destruction by desiccation.

* "Notes on the Rearing of *Stegomyia fasciata* in London." Journal of Tropical Medicine and Hygiene, 1st Sept. 1915.

The females were allowed to oviposit directly on the surface of water contained in petri dishes, or on to small pieces of filter paper that were floated on the water in order to give the insects a safer foothold than the surface-film presented. These eggs when examined were perfectly normal-looking, but immediately they were removed from the water or off wet paper they began to dry up, with the same shrinkage of the contents, and collapse of the shell. Such eggs when again placed on water and kept at a temperature of 64° F. failed to develop, the embryo having been killed by drying.

I was therefore left to account in some way for the fact that eggs which had reached London from West Africa had withstood desiccation for over three months, while the eggs laid by the mosquitos here in London were exceedingly liable to destruction by drying.

Conjecturing the possibility that the eggs when laid might be protected by some substance in the shell that was soluble in or destroyed by water, and that only the eggs laid out of water were able to resist desiccation, the following experiments were undertaken:—

Experiment No. 1.

Several fertilised and fully fed females were placed individually in separate glass tubes containing a smaller tube which held a little water and was plugged with filter-paper, to furnish a small damp surface on which the females might be induced to lay their eggs. Oviposition on the filter-paper took place normally about four days after the mosquitos had fed. The eggs were laid during the night, and were examined about 10 o'clock the following morning by means of a binocular microscope, at first *in situ*, and later after removal to a piece of dry filter-paper. I was surprised to see that the interstices of the wet paper held a much larger amount of water than would have been supposed when looked at with the naked eye, and that each egg was in effect lying in a minute pool among the waterlogged paper fibres. The eggs were therefore to all intents and purposes in the same condition as those laid directly on the surface of the water in the petri dishes, and when removed to dry paper began soon afterwards to dry up and collapse in the same way. Accordingly the need of furnishing the mosquitos with something on which they could be induced to lay their eggs, and which yet held only traces of moisture insufficient to dissolve or destroy any protective substance that might be contained in the egg-shell, became apparent.

After numerous trials, clover-leaves that had been first thoroughly dried, later steeped in water until they were soft and pliable, and then pressed between folds of blotting paper until there was little water remaining in the tissues, were found to answer the purpose.

Experiment No. 2.

A few of the damp clover-leaves were loosely packed into the bottom of small glass tubes, and a fertilised and fully fed female mosquito was imprisoned in each. During the course of a day or two a few eggs were laid by the mosquitos, but all when examined were collapsed.

By the foregoing experiments, the assumption that the shell might contain some substance protecting the egg from desiccation, but which itself was soluble in or destroyed by water, was proved to be wrong, and the problem remained to be explained in some other way.

The reverse idea then suggested itself, namely, that not until the egg had been in contact with water for some time and the embryo partially developed was the shell rendered resistant to drying. The results obtained in earlier experiments, when the leaves from West Africa were placed on water, in so far as the larvae hatched within a few hours, also favoured this view, as showing that the embryo was well developed in the resistant eggs.

Ten fertilised and fully fed mosquitos were therefore placed in a small cage containing the usual petri dish of water on which they might oviposit. On the night of the fourth day after feeding, large numbers of eggs were laid, and these were divided into ten approximately equal batches at 10 o'clock the next morning. Oviposition had not commenced by 6 o'clock on the night of the fourth day when I left the laboratory, and thus the maximum time that the first eggs could have remained on the water ere they were divided into equal batches, may be roughly estimated at 15 hours.

Each of the 10 batches of eggs was allowed to remain in water for different periods, and was then collected on filter-paper and allowed to dry slowly at the temperature of the laboratory (64° F.). The following table gives the results :—

Maximum time eggs remained in water.	Percentage collapsed after drying for 12 hours.
15 hours.	100%.
20 ,,	100%.
25 ,,	100%.
37 ,,	62%.
43 ,,	28%.
48 ,,	2%.
60 ,,	0%.
65 ,,	0%.
70 ,,	0%.

Contact with water for some time is clearly shown in the above table to be necessary in order that the eggs may become resistant to desiccation. Whether this is due to some change in the egg-shell itself or to development of the embryo and its enveloping membranes is a subject of study at the present time, as is also the question of the longest period that eggs will resist desiccation. The latter is a point of some doubt, and has been put at various lengths of time by different investigators. Patton and Cragg state, "Francis has shown that the eggs of *S. fasciata* may remain viable for as long as six and a half months when they are kept dry; they do not however hatch after two years. Peryassu found that after five and a half months the eggs would not hatch."* Also it has been shown by Theobald that they would survive out of water for a considerable time, and in an exact experiment by Newstead, with eggs that were sent from Manaos, South America, to England, that they could remain dormant for forty-two days, while in the paper already referred to I have shown that they survived for at least three and a half months.

*"A Textbook of Medical Entomology," by Patton and Cragg.

No doubt the duration of the resistant period may be altered by the length of time that the eggs are first in contact with water.

Fig. 2. Collapsed eggs of *Stegomyia fasciata*. × 20.

Figs. 2 and 3 are photomicrographs of eggs from the same batch. Those in Fig. 2 were removed from the water about 15 hours after they had been laid, and were allowed to dry on filter-paper at the laboratory temperature (64° F.). They had completely collapsed 15 minutes after being placed on the paper.

Fig. 3. Resistant eggs of *Stegomyia fasciata*. × 14.

Fig. 3 shows eggs from the same batch as the foregoing, removed from the water ½ days later. They were allowed to dry on filter-paper in the same way, and were photographed 12 hours after they were thoroughly dry. These eggs, moreover, while being photographed, were exposed to the condensed beam of an electric arc light for over an hour, with neither heat nor colour screens interposed, and were thus subjected to considerable heating. Both sets of eggs after they had been photographed were separately brushed into glass tubes, to each of which water was added. The collapsed eggs failed to hatch, but the normal-looking eggs (fig. 3) notwithstanding having been subjected to desiccation, considerable heat, and intense light, hatched out six hours later active larvae that developed normally into imagos of normal size.

Remarks.—The resistance of the eggs of *S. fasciata* to desiccation is only attained after the eggs have been in contact with water for some time, and with the definite results that I have had in these experiments, my former conviction that the partially collapsed eggs from West Africa had also hatched out is probably incorrect. A larger number of normal-looking (i.e., resistant) eggs than were visible on the leaves may have been present buried in the mud deposit previously mentioned, and these would account for the surprisingly large number of larvae that were hatched.

The embryos of freshly laid eggs are very easily killed by drying, and if such eggs are removed from water only long enough for the first evidences of the shell collapse to appear, and are then replaced on water, it has been found that they fail to develop.

Naturally laboratory experiments cannot altogether simulate conditions in nature, and the degree of humidity of the atmosphere in certain tropical places may play an important rôle in allowing even freshly laid eggs when removed from the water to develop their resistant powers, but the fact is demonstrated at least that these eggs are particularly liable to destruction by desiccation.

SOME EXPERIMENTS ON THE BREEDING OF THE MANGOLD FLY (PEGOMYIA HYOSCYAMI, PANZ.) AND THE DOCK FLY (PEGOMYIA BICOLOR, WIED.).

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In a previous paper (Ann. Applied Biol. i, 1914, pp. 41–76) in which the author dealt with the life-history of *Pegomyia hyoscyami*, Panz., it was shown that the food-plants of this species belonged principally to the natural orders Chenopodiaceae and Solanaceae. Various weeds have also been cited in this connection, namely, certain kinds of thistle and the dandelion. Recently E. M. Vassiliev (see Rev. Appl. Ent. iii, Ser. A., 1915, p. 608) has added to the record the following:—*Silene* (catchfly), *Datura stramonium* (thorn-apple) and *Onopordon acanthium* (Scotch thistle). Thus, in addition to the two aforementioned, the orders Caryophyllaceae and Compositae are fairly well represented. As the original paper of the Russian author is not available, it cannot be definitely stated in how far his records are authentic. But as he advises the removal of these weeds from the vicinity of beet plantations, one would naturally infer that he has some reason for assuming that they may be attacked by the mangold fly and presumably provide an ever-present source of infestation to the cultivated crop.

As we have already stated (*loc. cit.* p. 69), all suppositious assertions regarding the food-plants of an insect species must be accepted with reserve, unless conclusive proof is forthcoming in support. Although there may be a bad attack of mangold fly in any one locality, we cannot therefore infer that weed plants in close proximity which show similar damage are being also attacked by the same species. There are several kinds of leaf-mining flies, and it is useless to argue that because a mangold or beet plant has its leaves blistered, a similar condition in the case of thistles or any other weed has been caused by the same species of maggot. It is our conviction that this jumping at conclusions has led to the error now widely accepted and presented in Leaflet 5 of the Board of Agriculture and Fisheries, that the dock is also a host plant of the mangold fly, whereas the insect that attacks the dock is really *Pegomyia bicolor*, Wied., an allied species. In some cases another species is found to mine in dock leaves, namely, *Pegomyia nigritarsis*, Zett., which can be readily distinguished from *P. bicolor* in both the larval and adult stages (*loc. cit.* p. 64).

The whole question of the food-plants of the mangold and dock flies requires thorough revision, and experiments were undertaken at Holmes Chapel, Cheshire, with this end in view. It was found that only a few of the questions could be dealt with in one season, and it was hoped that the work might be continued in the following and subsequent summers. Thus, although finality has been by no means attained, we consider it important that the results should be published.

A previous attempt was made on a small scale to ascertain whether adults of *P. hyoscyami*, reared from larvae which had fed on belladonna leaves, would oviposit on the leaves of mangold wurzel (*loc. cit.* p. 69). The results were entirely negative,

but it was recognised that the narrow confines of the breeding cages then employed were detrimental to the display of the insects' normal activities. In order to eliminate, so far as possible, all objections that could be raised on this score, a large frame-structure cage covered with coarse grade, closely woven muslin was erected in the field at the farm of the Agricultural College, Holmes Chapel. The cage measured 50 feet long, 14 feet broad and 5 feet high, giving a total capacity of 3,500 cubic feet. By erecting partition walls of muslin, the cage was divided into five equal-sized compartments of $10 \times 14 \times 5$ feet, which gave a capacity for each of 700 cubic feet. This allowed for sufficient space in which one might conveniently attend to the experiments. It may be mentioned that in order to lessen the risk of tearing under the stress of wind and wet, the muslin was securely fastened by means of narrow strips of wood nailed to the supports. Similarly, the muslin on the roof was attached to the cross-supports in like fashion. Midway between the cross-supports of the roof of each compartment and those of the sides and ends two similar strips of wood were nailed to each other with the muslin held firmly between. An idea of the general structure will be obtained from fig. 1.

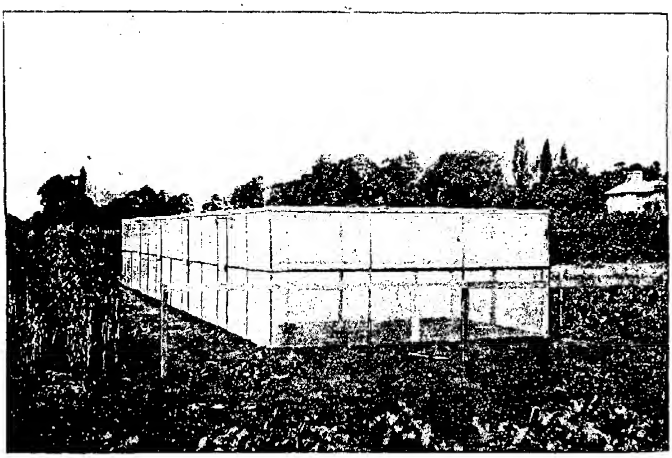

Fig. 1.

There was no communication between one compartment and another, but each was supplied with a small door just large enough to allow the experimenter to enter. All the doors, which were similarly placed on the same side of the cage, were covered with muslin, and great care was taken that they fitted closely to the jambs. The cage was absolutely fly-proof, so that those flies introduced into the compartments in the course of the experiments had no chance of escape, and, similarly, no random specimens could enter the cage from the outside. Several species of flies and various insects, other than those used in the experiments, were collected inside the cage, and of these *Leptis scolopacea*, L., *Leptis tringaria*, L., and *Empis tesselata*, F., predominated from June to September. Their larvae and pupae must have been present in the soil in large numbers, and when the adults emerged, they were imprisoned in the cage.

It was suspected that these predaceous insects attacked and killed a few of the mangold and dock flies. It is pretty certain, however, that a sufficient supply of material was maintained to render this factor negligible.

Inside the cage sugar-beets were sown in three of the compartments and mangolds in the remaining two. The drills ran lengthwise and were placed 27 inches apart. Throughout the summer the plants received careful attention, being singled, cultivated and kept free from weeds. Up to about the time that the seedlings were 6 inches above the ground there was a period of severe drought, which terminated on 25th June. It was therefore thought expedient to water the plants occasionally to prevent their flagging. With the extra attention paid to them they developed into strong healthy plants with large roots, rather better than those outside the cage, which were seriously affected by the attacks of black fly (*Aphis rumicis*, L.).

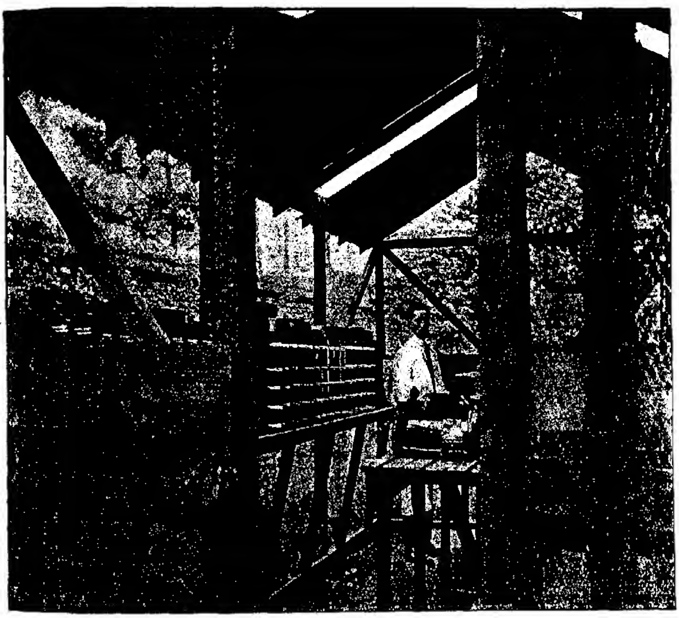

Fig. 2.

The scheme of the experiments was as follows. In compartment I., in which sugar-beets were grown, specimens of *P. bicolor* reared from docks (*Rumex obtusifolius*) were liberated. In compartments II. and III. sugar-beets were also grown, and the flies liberated were respectively *P. hyoscyami* reared on belladonna and *P. hyoscyami* reared on mangolds. In compartments IV. and V. mangolds were sown, and into the first of these specimens of *P. bicolor* reared from docks were introduced; in the other were specimens of *P. hyoscyami*. The method of procedure adopted was to collect as many mined leaves of dock, belladonna and mangolds as possible containing the infesting maggots. These were then isolated in different breeding boxes and bred through to the pupal condition in the insectary (fig. 2) attached to the field experiment

laboratory at Fallowfield, Manchester. In this condition they were taken to the field cage at Holmes Chapel, Cheshire, and introduced into their respective compartments. The puparia were buried about an inch or so below the surface of the ground, and doubtless a few were destroyed by terrestrial predaceous insects. The following are the details, with the dates on which the specimens were liberated in the cage:—

Compartment I. Sugar-beet. *P. bicolor* reared on dock.

June 22nd	199 puparia.
„ 25th	80 „
„ 29th	189 „
July 6th	200 „
„ 23rd	98 „
Aug. 24th	60 „
Sept. 3rd	126 „

Total, 952 puparia.

Compartment II. Sugar-beet. *P. hyoscyami* reared on belladonna.

June 22nd	30 puparia.
„ 29th	27 „
July 6th	76 „
„ 23rd	60 „
Aug. 5th	51 „
Sept. 3rd	56 „

Total, 300 puparia.

Compartment III. Sugar-beet. *P. hyoscyami* reared on mangold.

June 29th	145 puparia.
July 6th	100 „
Aug. 5th	7 „
„ 24th	90 „
Sept. 3rd	15 „

Total, 357 puparia.

Compartment IV. Mangold. *P. bicolor* reared on dock.

June 22nd	199 puparia.
„ 25th	80 „
„ 29th	189 „
July 6th	200 „
„ 23rd	97 „
Aug. 24th	61 „
Sept. 3rd	126 „

Total, 952 puparia.

Compartment V. Mangold. *P. hyoscyami* reared on belladonna.

June 29th	27 puparia.
July 6th	76 „
„ 23rd	60 „
Aug. 5th	51 „

Total, 214 puparia.

In this experiment no more specimens were introduced after oviposition took place.

Everything considered, the season was not very favourable for the successful prosecution of the experiments. The period of drought which persisted from the time of sowing, 26th May until 25th June, was followed by wet weather, which more or less continued up to the time that the work was concluded in the middle of September. During these dull, wet days the flies confined in the cage were inactive and sluggish. Bright, warm days, which appear to offer the best conditions for copulation, were conspicuous by their absence. Still, this does not offer a satisfactory explanation of the results; but the weather conditions served to impress us with the necessity of repeating the experiments for two or three years if the work is to have a determinative value.

Oviposition was first observed on 9th August in compartment V., where the adult females of *P. hyoscyami*, reared from maggots feeding on the leaves of belladonna, were actively engaged in laying their eggs on the mangold plants. A few days later the leaves of almost every individual plant had their quota of eggs, and in some cases the tiny maggots had hatched out and were busily engaged making incipient mines. On 3rd September the leaves were badly blistered. In order to determine any differences between the adults which were reared from these mangolds and those reared on belladonna, a number of puparia of both were separately isolated and the emerging adults retained. It was found that the differences were insignificant and amounted to a slight variation of colour. Those reared from mangold leaves were generally slightly darker, the abdomen being rather more cinereous than in the specimens reared on belladonna.

The fact that the result was positive in the case just considered would appear to necessitate an abandonment of the theory of "biologic" species which the author has postulated (*loc. cit.* p. 70), or, at the most, it can only be maintained in a modified form. It might be argued that in a confined space with only one kind of plant present, the fly had no choice but to oviposit on the mangold leaves. But since it is recognised that the presence of the food-plant is a stimulus to oviposition, we must believe that under certain circumstances mangolds will supply this stimulus equally with belladonna and induce the fertilised females of *P. hyoscyami* reared on the latter to lay their eggs on mangold leaves, if belladonna be not available.

A curious circumstance is that the *P. hyoscyami* of belladonna refused to oviposit on sugar-beet, whereas they did so freely on mangold in compartment V., although sugar-beet is merely a selected variety of mangold specially grown for its sugar content. Similarly in the case of compartment III., specimens of *P. hyoscyami* reared from mangold leaves failed to oviposit on the leaves of sugar-beet. In these two instances the theory of "biologic" species would appear to be established, but the facts ought to be confirmed by repeating the experiments.

In the case of compartments I. and IV. where *P. bicolor* reared on dock was confined with sugar-beet and mangold, the results turned out as the author expected. In both experiments the flies failed to oviposit. This rather strengthens our belief that the precaution of clearing out docks from the vicinity of mangold and sugar-beet crops is not likely to produce the results generally anticipated. Not that the farmer

would not be well advised to keep his land as clean as possible of these weeds, but that there is no evidence available that *P. bicolor* will migrate from docks to mangolds and beets. Therefore the removal of docks for the specific purpose of preventing mangolds and beets from being attacked by the dock fly rather misses the mark.

Conclusions.

It would appear from the foregoing experiments that the following conclusions might be considered to have been tentatively established :—

1. *P. hyoscyami* reared on belladonna will oviposit and complete its life-history on mangolds if belladonna be absent. Why this same species did not oviposit on the leaves of sugar-beet was not discovered.

2. *P. hyoscyami* reared on mangold leaves did not oviposit on those of the very closely allied sugar-beet. All that can be inferred from the experiment is that the species when reared on the leaves of the mangold will more readily oviposit on those of the same plant than on sugar-beet.

3. *P. bicolor* reared on dock does not oviposit and complete its life-history on the leaves of the mangold or sugar-beet. It may also be safely asserted that neither does *P. hyoscyami* reared on mangold or sugar-beet leaves oviposit on those of the dock.

4. Where weeds and cultivated plants have their leaves similarly blotched and blistered by leaf-mining maggots, one must make a careful examination of the insects before stating that the damage is due to one and the same agent. The author believes that hasty and immature judgment has led to the commonly accepted error that the maggot (*P. bicolor*) which mines in the leaves of the dock also attacks those of mangolds. That the insect which blisters the leaves of the common weed, goosefoot (*Chenopodium album*), is identical with the *P. hyoscyami* which causes similar injury to mangold leaves, there is no doubt. In how far there may be a migration, if any, of the insects between the two plants has not been experimentally established.

The author desires to acknowledge many valuable suggestions made by Dr. A. D. Imms during the progress of these experiments and to express his indebtedness to Professor S. J. Hickson.

ON MUTILLIDAE PARASITIC ON GLOSSINA MORSITANS.

By R. E. Turner.

Mutilla glossinae, Turn.

Mutilla glossinae, Turner, Bull. Entom. Res., v., 1915, p. 383, ♀.

♂. Niger, albo-pilosus; pronoto, mesonoto, scutelloque rufo-ferrugineis; calcaribus albidis; segmentis dorsalibus 2–4 apice anguste albo-fimbriatis; alis basi hyalinis, dimidio apicali modice infuscatis; mandibulis apice tridentatis. Long. 6 mm.

♂. Head narrower than the thorax, broader than long, rounded at the posterior angles, closely and not very finely punctured, the antennal tubercles well developed. Clypeus concave, smooth and shining. Third joint of the flagellum equal to the fourth, half as long again as the second and more than twice as long as the first. Eyes ovate, converging towards the clypeus, not emarginate; ocelli placed in a triangle, the posterior pair a little further from each other than from the anterior ocellus and situated on the inner edge of a large but shallow depression. Thorax broad and short, closely but not coarsely punctured; anterior margin of the pronotum straight, the posterior margin broadly arcuate; scutellum flat, broadly truncate at the apex; pleurae very closely punctured and sparsely clothed with long white pubescence. Median segment very coarsely reticulate, shorter than the scutellum, posterior slope very steep, not distinctly separated from the dorsal surface. Abdomen subsessile; closely punctured, with distinct but narrow apical bands of long white hairs on segments 2–4, a less clearly defined band on the first; apical dorsal segment broadly rounded, more coarsely punctured, the punctures more or less confluent longitudinally. Second ventral segment closely punctured and sparsely clothed with long whitish hairs, which form a continuous band on the apical margin. First dorsal segment short and broad, slightly depressed on the apical margin; second very broad, fully twice as broad as long, the sides convex. Fore-wing with three cubital cells, radial cell very broad, not more than twice as long as broad; first abscissa of the radius equal to the third, shorter than the second, the two recurrent nervures received near the middle of the second and third cubital cells.

Nyasaland: Monkey Bay (*Dr. W. A. Lamborn*).

A large series of both sexes bred out in October 1915, a smaller series having been bred in the previous June.

Mutilla benefactrix, sp. n. (figs. 1, 2).

♀. Nigra; mandibulis, antennis, thorace, pedibusque rufo-ferrugineis; segmento dorsali secundo macula magna basali albido-pubescente; segmentis dorsalibus secundo tertioque fascia apicali brunnea, albido-pubescente.

♂. Niger; albo-pilosus; thorace segmentoque mediano ferrugineis; mandibulis antennisque subtus fuscis; alis hyalinis, apice leviter infuscatis; calcaribus albis. Long. ♀, 4·5–5 mm.; ♂, 4·5–5·5 mm.

♀. Head as broad as the thorax, closely and deeply punctured, rounded at the posterior angles; eyes oval, situated rather nearer to the posterior margin of the head than to the base of the mandibles; antennal tubercles well developed, oblique;

second joint of the flagellum short, equal in length to the third, less than twice as long as the first. Thorax punctured-rugose, distinctly longer than the greatest breadth, a little broader at the apex than at the base; the sides straight, not rounded; pleurae finely punctured; the posterior slope of the thorax abrupt, the surface coarsely longitudinally rugose; scutellar tubercle distinct. Abdomen sessile; the first segment very small and sunk below the level of the second; the second dorsal segment very closely and not finely punctured, longer than the greatest breadth, the sides slightly convex, a large patch of whitish pubescence slightly tinged with fulvous at the base, and a narrow band of the same at the apex of both the second and third dorsal segments. Sixth dorsal segment convex, without a pygidial area.

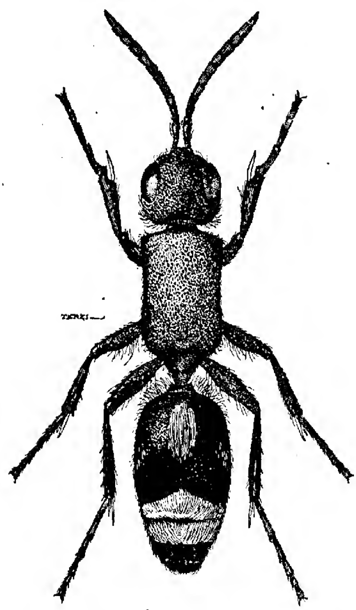

Fig. 1. *Mutilla benefactrix*, sp. n., ♀.

Carina of the first ventral segment very low; second ventral segment rather coarsely punctured, and sparsely clothed with long whitish hairs. Hind tibiae with four very slender spines on the outer margin. The sides of the posterior slope of the median segment very finely serrate.

♂. Head as broad as the thorax, finely and very closely punctured, covered with long greyish pubescence, a distinct sulcus running from the anterior ocellus to the base of the antennae. Posterior ocelli near together, very little further from each other than from the anterior ocellus; eyes deeply emarginate. Antennal tubercles well developed; third joint of the flagellum as long as the first and second combined.

Thorax closely and rather finely punctured; scutellum flat, rather broadly truncate at the apex. Median segment as long as the scutellum, coarsely punctured-rugose, abruptly truncate, the posterior slope distinctly divided from the dorsal area. Abdomen finely and closely punctured, with a very narrow apical band of white pubescence on the three basal dorsal segments; the first segment short, and depressed somewhat below the second, which is strongly convex, broader than long, and convex at the sides; seventh dorsal segment subtruncate at the apex. Second ventral segment rather more strongly punctured than the dorsal, sparsely clothed with long white hairs and with a distinct apical fringe of the same. Radial cell not more than twice as long as broad; first abscissa of the radius a little longer than the third,

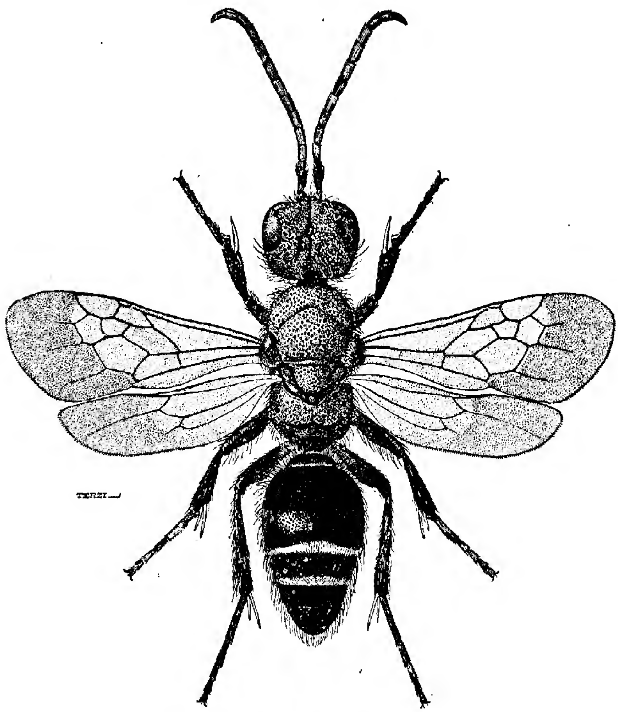

Fig. 2. *Mutilla benefactrix*, sp. n., ♂.

second scarcely half as long as the first. Third cubital cell not distinctly defined, receiving the rather indistinct second recurrent nervure near the apex, first recurrent nervure received just beyond the middle of the second cubital cell.

Nyasaland: Monkey Bay, viii. 1915 (*Dr. W. A. Lamborn*).

Three pairs bred from pupae of *Glossina morsitans*.

This seems to belong to the group of *M. thyone*, Pér., but differs in sculpture, in the serrulate sides of the posterior slope of the thorax of the female and in other details.

COLLECTIONS RECEIVED.

The thanks of the Imperial Bureau of Entomology are due to the following gentlemen, who have kindly forwarded collections of insects (received between 1st October and 31st December, 1915):—

Dr. W. M. Aders:—9 Culicidae, 16 other Diptera, and 11 tubes of intestinal worms; from Zanzibar.

Mr. E. Ballard, Government Entomologist:—17 Diptera, 4 Hymenoptera, 187 Coleoptera, 192 Lepidoptera, 103 Rhynchota, 28 Orthoptera, and 1 tube of Leeches; from South India.

Mr. C. Beeson, Forest Zoologist:—126 Curculionidae; from Dehra Dun, India.

Mr. G. E. Bodkin, Government Economic Biologist:—1 Culicid, 3 *Tabanus*, 1 Chalcid, 124 other Hymenoptera, 6 Coleoptera, 6 Lepidoptera, about 100 Mallophaga, 2 species of Coccidae, 28 other Rhynchota, 62 Odonata, 5 Orthoptera, 16 Gamasid mites, 2 Argulidae, 1 Leech, and a number of intestinal worms; from British Guiana.

Dr. A. S. Burgess, W.A.M.S.:—32 Culicidae; from the Gold Coast.

Dr. G. D. H. Carpenter:—7 Diptera, numerous Braconidae, 18 other Hymenoptera, 66 Coleoptera, 13 Rhynchota, 3 Orthoptera, 1 Tick, 1 Pseudoscorpion, and 1 Slug; from Uganda.

Mr. E. C. Chubb, Curator of the Durban Museum:—33 Tabanidae, 27 Trypetidae, 6 Hippoboscidae, 98 other Diptera, 142 Rhynchota, and 66 Odonata; from Natal and Nyasaland.

Mrs. Andrew Connal:—305 Culicidae, 5 Tabanidae, and 2 other Diptera; from Lagos, Nigeria.

Mr. M. H. Dawe:—6 Diptera, and 5 larvae; from Colombia.

Mr. d'Emmerez de Charmoy, Government Entomologist:—40 Chalcids, 23 Moths, and 1 sp. of Coccidae; from Mauritius and Réunion.

Division of Entomology, Pretoria:—15 Diptera, 6 Chalcids, 9 other Hymenoptera, 51 Coleoptera, 35 Lepidoptera, 4 Myrmeleonidae, 46 Rhynchota, 2 Odonata, and 7 Orthoptera; from South Africa.

Mr. P. R. Dupont, Curator of the Botanic Station:—80 Coleoptera; from the Seychelles.

Geneeskundig Laboratorium, Buitenzorg:—218 Culicidae; from Java.

Dr. Lewis H. Gough, Director, Entomological Section, Ministry of Agriculture:—2 Culicidae, 2 Tabanidae, 5 other Diptera, 33 Hymenoptera, 4 Coleoptera, 7 Planipennia, 6 Rhynchota, and 8 Odonata; from Egypt.

Mr. C. C. Gowdey, Government Entomologist:—1 *Haematopota*, 22 other Diptera, 231 Hymenoptera, 437 Coleoptera, 5 Psychid cases, 72 Termites, 32 Thysanoptera, 8 lots of Coccidae, 133 other Rhynchota, 10 Orthoptera, and 23 Ticks; from Uganda.

Mr. Ernest Hargreaves:—About 100 Chalcids, 58 Ants, 30 larvae, 14 pupae, and 10 imagines of the weevil *Anthonomus grandis*, 16 other Coleoptera, 2 envelopes of Coccidae, 3 slides of Aleurodidae, and 2 slides of Mites; from the United States.

Mr. Gerald F. Hill, Government Entomologist:—1 Hippoboscid, 10 other Diptera, 455 Hymenoptera, 17 Coleoptera, 14 Lepidoptera, 9 species of Coccidae, 116 other Rhynchota, about 30 Psocids, and 3 Orthoptera; from the Northern Territory of Australia.

Mr. E. Hutchins, Chief Veterinary Officer:—103 Tabanidae, and 32 other Diptera; from Uganda.

Commander H. Hutchinson:—8 Culicidae, 14 Tabanidae, 1 *Glossina*, 27 other Diptera, 29 Hymenoptera, 3 Coleoptera, 8 Rhynchota, and 13 Ticks; from Uganda.

Dr. A. Ingram, W.A.M.S.:—168 Culicidae, and 184 early stages; 6 *Phlebotomus*, 8 *Culicoides*, 45 Tabanidae, 100 *Glossina*, and 29 other Diptera; from the Gold Coast.

Dr. W. A. Lamborn:—3 *Pangonia*, 70 *Auchmeromyia*, about 200 puparia of *Glossina morsitans*, with 25 Bombyliid parasites, 195 other Diptera and dipterous puparia, 173 Lepidoptera, about 300 Chalcids, about 400 other Hymenoptera, 69 Coleoptera, 2 Mayflies, 5 Rhynchota, 15 Orthoptera, 6 Odonata, and 2 tubes of Ticks; from Nyasaland.

Mr. S. Leefmans, Laboratorium von Plantenzeikten, Buitenzorg:—8 specimens of the banana scab moth, *Nacoleia octosema*, Meyr.; from Java.

Mr. C. W. Mally, Cape Province Entomologist:—5 Weevils; from Capetown.

Mr. C. Mason, Government Entomologist:—26 *Tabanus*, 15 other Diptera, 9 Chalcids, 9 Braconids, 11 Coleoptera, 31 Lepidoptera, and 2 Rhynchota; from Nyasaland.

Mr. F. W. Urich, Government Entomologist:—3 Coleoptera, 10 Lepidoptera, and about 50 Gamasid mites; from Trinidad.

Mr. Robert Veitch:—78 Culicidae, 19 other Diptera, about 130 Hymenoptera, 39 Coleoptera, 43 Lepidoptera, 1 tube of Coccidae, 30 other Rhynchota, 5 Odonata, and 2 Millipedes; from the Fiji Islands.

The Wellcome Bureau of Scientific Research:—20 Culicidae, 98 other Diptera, 19 Hymenoptera, 6 Coleoptera, 9 Rhynchota; from Columbia, Grenada, and Venezuela.

ON THE FRUIT-FLIES OF THE GENUS DACUS (s. l.) OCCURRING IN INDIA, BURMA, AND CEYLON.

By Prof. M. Bezzi,

Turin, Italy.

As stated in my previous paper* on the Ethiopian species of *Dacus*, the Oriental forms of this genus show much more variation in their structural and ornamental features. They may be therefore divided into no less than five well defined genera, only one of which is common to both faunal areas. Reserving for later publication a third paper on the Oriental (and Australian) species, I will give here some notes on the classification and feeding habits of the species from British India.

Since the publication in 1913 of my paper on the Indian Trypaneids,† I have received from various sources a large amount of material, which enables me to give a better definition of the species and to add much information as to fruits on which they feed. The material was received :—(*a*) from the Imperial Bureau of Entomology; (*b*) from the Indian Museum, Calcutta; (*c*) from the Pusa Agricultural Research Institute, forwarded by the Imperial Entomologist, Mr. T. B. Fletcher, who has supplied the data as to the host fruits; (*d*) from the Dehra Dun Forest Research Institute, forwarded by Professor A. D. Imms; (*e*) from Professor L. Petri of Rome, material bred at Peradeniya, Ceylon, by Mr. E. E. Green; (*f*) from Professor E. Bugnion, of Lausanne, material collected by him in Ceylon.

The fruit-flies which are grouped around *Dacus* are principally distinguished from other Trypaneids by their reduced chaetotaxy, as established by me and accepted by Professor Hendel in his synopsis of the genera of the family.‡ This reduction consists in the *simultaneous* disappearance of the following macrochaetae :—ocellar, post-vertical, humeral, praesutural, dorso-central and sternopleural; usually the bristles of the occipital row and those on the under side of the front femora are also wanting or much reduced. There are no other genera of fruit-flies in which all these bristles are wanting *at the same time*, except a few Oriental genera in which this is the case, though they have not a *Dacus*-like appearance. They must however be associated with the true Dacinae, and they constitute another peculiarity of the Oriental fauna as compared with that of the Ethiopian region.

The following is a table of the Oriental and Australian genera of Dacinae at present known :—

1 (12). Arista bare; scutellum broader than long, rounded, convex above, not carinate at the sides; abdomen not linear, usually broader than the thorax; wings

*Bull. Ent. Research, vi, September, 1915, pp. 85–101, 14 figs.

†Indian Trypaneids (Fruit-flies) in the Collection of the Indian Museum, Calcutta. *Memoirs of the Indian Museum*, iii, No. 3, May 1913, pp. 51–175, pl. viii-x.

‡Die Gattungen der Bohrfliegen; analytische übersicht aller bisher bekannten Gattungen der Tephritinae. *Wien. entom. Zeitung*, xxxiii, April 1914, pp. 73–98.

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with the first three longitudinal veins closely approximated, the anterior cross-vein long and oblique, the second basal cell dilated and the anal cell drawn out into a very long point.

2 (7). Antennae as long as or shorter than the face, with the first joint not elongated and shorter than the second; face hollowed in the middle; abdomen never stalked, though sometimes a little constricted at base; second basal cell short, usually not more than twice as long as broad.

3 (4). Thorax without anterior supra-alar or praescutellar bristles; wings of the male without the supernumerary lobe at end of anal vein .. .. *Dacus*, F. (*s. str.*).

4 (3). Thorax with well developed anterior supra-alar and praescutellar bristles; wings of male usually with supernumerary lobe at end of anal vein.

5 (6). Wings banded .. .. *Bactrocera*, Guér.

6 (5). Wings not banded .. .. *Chaetodacus*, Bezzi.

7 (2). Antennae much longer than the face, with the first joint usually elongated and as long as the second; face not hollowed, usually flat or even convex; abdomen distinctly stalked, club-shaped; thorax without praescutellar bristles; wings with the second basal cell more elongate, many times longer than broad, and without supernumerary lobe in the male.

8 (11). The basal joints of antennae wholly separated.

9 (10). Face flat; thorax with the transverse suture broadly interrupted in the middle and without unpaired acrostichal bristles; front femora not spinose beneath; second portion of fourth longitudinal vein straight, the discoidal cell less narrowed at base .. .. *Mellesis*, gen. nov.

10 (9). Face distinctly convex; thorax with the transverse suture not interrupted, and often with a strong acrostichal bristle on the middle line; front femora with some spines beneath near the apex; second portion of fourth vein deeply sinuose, the discoidal cell much narrowed in its basal half .. .. *Monacrostichus*, Bezzi.

11 (8). Basal joints of antennae united in the shape of a common petiole *Callantra*, Walker.

12 (1). Arista short plumose; scutellum longer than broad, triangular, flat above, distinctly carinate at the sides; thorax without praescutellar bristles; abdomen linear, narrower than the thorax; middle femora elongated and thickened; wings with the first three veins not approximated, the anterior cross-vein short and placed perpendicularly, the second basal cell not dilated and the anal cell with a short point.

13 (14). Femora not spinose beneath; thoracic suture interrupted in the middle; ovipositor compressed; antennae short .. .. .. *Neosophira*, Hendel.

14 (13). Femora spinose beneath; thoracic suture complete.

15 (16). Antennae shorter than the face, pendulous; thorax with anterior supra-alar bristle; scutellum with four bristles; ovipositor conical. .. *Adrama*, Walker.

16 (15). Antennae very long, porrect, twice as long as the face; no anterior supra-alar bristles and only one pair of scutellar bristles; ovipositor compressed *Meracanthomyia*, Hendel.

i. Dacus, F.

1. **Dacus (Leptoxyda) longistylus,** Wied. (1838).

Bezzi, Bull. Ent. Res., v, 1914, p. 154, and vi, 1915, p. 99.

Some specimens of both sexes in the Indian Museum from Balighai, near Puri, Orissa, 16-20.viii.1911 (*N. Annandale* and *F. H. Gravely*), and some others from Coimbatore, vi.x.1913, on *Calotropis* (*T. B. Fletcher*); Nagpur, 9.iv.1914, on *Calotropis*.

No doubt this is the same as the African species which lives on the same plant (*Calotropis procera*), and which was doubtfully recorded by me in 1913 from Karachi. The Indian specimens before me are very like those from Egypt and equally small, while the specimens from Abyssinia and Senegal are more robust and of much larger size. The ovipositor is also proportionally shorter in the smaller Egyptian and Indian form.

2. **Dacus brevistylus,** Bezzi (1908).

Bezzi, Bull. Ent. Res., v, 1914, p. 154, and vi, 1915, p. 100.

Some specimens of both sexes from Hagari, v.1908, in watermelon (E. Ballard); Siddhout, Cuddappale, Madras, iv. 1910, in melon; Coimbatore, 26. iv. 1912, in melon (*T. B. Fletcher*).

This is the well-known Ethiopian species that attacks melons and other cultivated Cucurbitaceae. Some specimens have the thoracic markings and the scutellum of a reddish instead of a yellow colour; a single specimen shows a double hypopleural spot, thus forming a link with *D. vertebratus*, Bezzi.

Note.—Of other Oriental or Australian species belonging to the genus *Dacus* (*s. str.*), I know only *D. cucumis*, French (1907), from Queensland, which has, however, four scutellar bristles, a thing which has never been observed in any Ethiopian species of the genus.

ii. Bactrocera, Guér. (1832).

No species of this genus is at present known from the Indian fauna; besides the typical species *umbrosa*, F., it seems that *frauenfeldi*, Schiner, *frenchi*, Froggatt, and *albistrigata*, Meij., also belong here.

iii. Chaetodacus, Bezzi. (1913).

In my paper of 1913 nine forms of this group were distinguished, but the distinctions were based on very scanty material; at present I have before me many hundreds of specimens, and I am able to give a better revision. Some species seem to be very variable in the colouring of the body and wings, as is shown by the bred material of *ferrugineus* and *cucurbitae*; the fuscous punctuation of the frons and the black pattern on the thorax and abdomen seem to be chiefly subject to variation. The studies of Prof. Berlese on *D. oleae* (*Redia*, iv, 1906, pp. 5-7, fig. 4) also confirm the great variability of the thoracic and abdominal markings in the present genus. I think therefore that Prof. Hendel* has described some forms which must be considered only as varieties, and I have made here an attempt to differentiate the various forms into which the typical *D. ferrugineus* may be divided.

*F. Hendel. Genus *Dacus*, Fabricius (1805) (Dipt.). *Supplem. Entomolog.*, No. 1, August 1912, pp. 13-24, pl. 1.

I have also corrected my previous error concerning the interpretation of *zonatus*, *mangiferae* and *persicae*, after seeing typical specimens of this last species. Finally I have added six new species, one of which has already been described,* and another known hitherto only from Sumatra.

The Indian species can now be distinguished as follows :—

1 (22). Scutellum with a single pair of bristles, the apical one.

2 (17). Two pairs of lower fronto-orbital bristles.

3 (16). Vertical, thoracic and scutellar bristles yellow; face always with black spots; thorax without yellow middle stripe; third abdominal segment of male ciliated; wings without dark spot on hind cross-vein.

4 (9). Wings with well developed brown anal stripe and with complete brown fore border; first basal cell microscopically pubescent in the portion over the second basal cell; fore and hind tibiae blackened.

5 (8). Thorax reddish on the disk, with or without black markings; pleurae reddish, the yellowish mesopleural stripe being sometimes margined with black; mesophragma reddish or partly black; ovipositor reddish; coxae of all the legs reddish; scutellum not spotted; occiput reddish.

6 (7). Back, pleurae and mesophragma altogether reddish, sometimes with a black border on front side of mesopleural stripe; frontal spots less distinct
3. *ferrugineus*, F.

7 (6). Back black, but reddish around the humeral calli, on the borders of the suture and before scutellum; mesopleural stripe always margined with black on both sides; mesophragma blackish on the sides .. 4. *ferrugineus dorsalis*, Hend.

8 (5). Thorax, pleurae and mesophragma entirely black, with the usual yellow markings; ovipositor black; hind coxae and trochanters black; a distinct darkish spot at end of the scutellum .. .. 5. *ferrugineus incisus*, Walk.

9 (4). Anal stripe not distinct; brown fore border incomplete; first basal cell wholly hyaline.

10 (11). Scutellum of a pellucid brownish colour, with two more or less distinct basal yellow spots; brown fore border usually indistinct, and apical brown spot wanting; facial black spots broad; fore and hind tibiae blackened; species of greater size .. .. 6. *ferrugineus versicolor*, var. n.

11 (10). Scutellum altogether yellow; wings with an isolated apical brown spot; facial spots smaller; fore tibiae yellow; hind tibiae yellow, at least in middle; species of smaller size.

12 (13). Thorax entirely reddish, with the usual yellow markings and the mesopleural stripe rarely margined with black; facial black spots of rounded shape, isolated; ovipositor red, with black end .. .. .. 7. *zonatus*, Saund.

13 (12). Thorax mainly black on disk and pleurae with the usual yellow markings.

14 (15). Facial black spots separated and rather broad; abdomen of male entirely black behind the second segment; legs with the coxae entirely yellow .. .. 8. *tuberculatus*, sp. n.

*M. Bezzi. Two new species of Fruit-flies from Southern India. *Bull. Ent. Res.*, v, September 1914, pp. 153-154.

15 (14). Facial spots more or less united together towards the middle, forming a transverse band; abdomen of male reddish behind the middle, with a black longitudinal middle stripe; ovipositor red .. .. .. 9. *correctus*, nom. n.

16 (3). Vertical, thoracic and scutellar bristles black; face of male immaculate; thorax with a middle longitudinal yellow stripe; third abdominal segment of male not ciliated; ovipositor very long and thin, black; wings with a distinct brown spot at lower end of hind cross-vein .. .. 11. *diversus*, Coq.

17 (2). Three pairs of lower fronto-orbital bristles, the two apical pairs being closely approximated; all the bristles of head and thorax black.

18 (19). Reddish species, with entirely yellow scutellum and a middle yellow stripe on thorax; femora entirely yellow; wings with the hind cross-vein broadly infuscated and with very broad anal stripe .. .. .. 14. *cucurbitae*, Coq.

19 (18). Blackish species, with black or black-spotted scutellum; femora partly black; wings with the hind cross-vein not infuscated.

20 (21). Scutellum yellow, with a black terminal spot; thorax with a middle yellow stripe; wings with well developed anal streak .. 17. *scutellarius*, sp. n.

21 (20). Scutellum black, with a small yellow spot on each side; no yellow middle stripe on thorax; wings without anal stripe .. 18. *biguttatus*, sp. n.

22 (1). Scutellum with two pairs of bristles, the basal and the apical; all the bristles of the body black.

23 (30). Only two pairs of lower fronto-orbital bristles.

24 (25). Wings absolutely without any brown marking at apex or even on anal vein, and without the supernumerary lobe in the male; face altogether black; scutellum black, with two broad yellow spots; third abdominal segment of male ciliated .. .. 19. *bipustulatus*, Bezzi.

25 (24). Wings with distinct brown pattern and well developed anal stripe; face yellow, with black bands or black spots; scutellum entirely yellow, immaculate.

26 (27). Thorax reddish; face with black spots; third abdominal segment of male not ciliated; wings without supernumerary lobe in the male, and with the angle at end of anal cell of equal size in both sexes .. .. .. 16. *garciniae*, Bezzi.

27 (26). Thorax black; third abdominal segment of male ciliated; wings of male with distinct anal lobe and with the usual sexual dimorphism of anal cell.

28 (29). Face in both sexes with two parallel transverse black bands; thorax without middle yellow stripe .. .. 10. *duplicatus*, sp. n.

29 (28). Face with the two usual black spots; thorax with middle yellow stripe 13. *hageni*, Meij.

30 (23). Three pairs of lower fronto-orbital bristles; yellow middle stripe of thorax always present; males always with ciliated third abdominal segment and with supernumerary anal lobe to the wings.

31 (34). Scutellum entirely yellow, without any definite black apical spot, or with a less distinct brownish one.

32 (33). Face with two black spots; femora yellow; wings with the brown fore border dilated into a broad spot at end, and with the hind cross-vein lightly margined with fuscous at lower end .. .. 15. *caudatus*, F.

33 (32). Face in both sexes with a middle black cross band; femora black at end; wings without broad apical spot and with the hind cross-vein not shaded below .. .. 12. *maculipennis*, Dol.

34 (31). Scutellum with a definite black spot at end; black species, with partly black femora; wings with an isolated black spot at end .. 20. *scutellaris*, Bezzi.

3. Chaetodacus ferrugineus, F. (1794).

Bactrocera ferruginea, Bezzi, Mem. Ind. Mus., iii, 1913, p. 95, pl. viii, fig. 5.

Taking as the main character for this species the yellow bristles of the head, thorax and scutellum, I will assume for typical specimens those which show a complete reddish coloration of the body, without any black pattern on the disk of the mesonotum, and with a black margination of the mesopleural stripe, or with a faint one on the anterior side alone. The frontal dark spots are wanting or less developed; the facial black spots are very broad; the pteropleural bristle is weak; the occiput is red with a yellow border. The white-dusted band of the hind border of the second abdominal segment is less distinct.

Thus defined, *C. ferrugineus* (*s. str.*) is easily recognisable, but it is impossible to take as the principal character that of the unspotted frons, as is done by Hendel (Suppl. Entom., i, 1912, p. 20); immature specimens have an entirely reddish frons, while in mature specimens there are more or less distinct central and lateral dark spots.

In my above-quoted paper of 1913, under the name of *ferruginea* are comprised the present and the following three forms (*dorsalis*, *incisus* and *versicolor*); they may be considered as varieties of a single species, inasmuch as all are to be found living at the same time in the same fruits.

I have seen specimens from Peradeniya, Ceylon (*Prof. Bugnion*); from Katihar, Purneah Distr., N. Bengal, v.1910 (*Paiva*); from Pusa, Bihar, April to July, bred from guava (*Psidium guyava*) and loquat (*Eriobothrya japonica*) fruits, together with the form *versicolor*, which is hardly distinguishable, the scutellar coloration being often faintly indicated and the wing characters being fully developed only in mature specimens; from Mandalay, on mango (*Mangifera indica*) vi. 1912 (*K. D. Shroff*); from Myit-Kyina, Upper Burma, in peach (*Prunus persica*) and in pomelo (*Citrus decumana*) fruits, June and September (*T. B. Fletcher*); from Maymyo, 3,500 ft., Upper Burma, v.1909, larva in mango (*K. D. Shroff*).

4. Chaetodacus ferrugineus dorsalis, Hendel (1912).

Dacus dorsalis, Hendel, Suppl. Entom., i, 1912, p. 18, pl. 1, fig. 3.

Most specimens referred by me to *ferrugineus* in 1913 belong to the present form, described originally from Formosa. It may be distinguished from the preceding form by the characters given in the table; the occiput is red, with dark spots.

There are before me specimens from Peradeniya, Ceylon (*E. E. Green*); Pusa, Bihar, 16.iv.1914, in loquat (*Eriobothrya japonica*) (*T. B. Fletcher*); Coimbatore, South India, on mango (*Mangifera indica*) 16.vii.1913 (*T. B. Fletcher*); Taru, Peshawar Dist., bred from peach (*Prunus persica*), viii.–ix.1914 (*T. B. Fletcher*); Mandalay, in mango and in chilly (*Capsicum frutescens*), 22.vi.1912 (*K. D. Shroff*); Myit-Kyina, Upper Burma, in pomelo (*Citrus decumana*), 13.ix. 1914, and in guava

(*Psidium guyava*), 1.x.1914 (*T. B. Fletcher*); Lashio, 3,000 ft., and Tatkon, U. Burma, in *Solanum verbascifolium*, 6-7.ix.1914 (*T. B. Fletcher*); Maymyo, 3,500 ft., Upper Burma, in American chillies (*Capsicum sp.*), in pear (*Pyrus communis*) and in peach (*T. B. Fletcher*).

5. **Chaetodacus ferrugineus incisus,** Walker (1860).

This is a very common Indian form, distinguished by the prevalent black colour of the entire body; the legs are also in great part black; the frontal spots are much developed and much darker than usual. The spot at the end of the scutellum is not defined, but in certain lights is rather distinct and pellucid. The puparium of this form is of a straw-yellow colour, rather shining, with the stigmatic plates approximated and with less distinct segmentation.

I have seen a great many specimens from the following localities:—Kumaon, 10.i.1912 (*Prof. A. D. Imms*); Pollibetta, South Coorg, from jak fruit (*Artocarpus integrifolia*), 15–26.v.1914 (*T. B. Fletcher*); Santikoppa, North Coorg, from fruits of *Careya arborea*, 4–10.v.1914 (*T. B. Fletcher*); Bangalore, 3,000 ft., on mango leaves, 8.v.1913, and on guava fruits (*Psidium guyava*), 27.x.1907 (*T. B. Fletcher*); Coimbatore, attacking mango fruits (*Mangifera indica*); Tatkon, Upper Burma, in *Solanum verbascifolium*, 6–7.ix.1914, Lashio, 3,000 ft., on same plant, viii.1914, and Taung-gyi, 1.iii.1910 (*T. B. Fletcher*).

6. **Chaetodacus ferrugineus versicolor,** var. nov.

♂ ♀. Length of body, 5·5–6·5 mm. Very like typical *ferrugineus*, but at once distinguished by the coloration of the scutellum; this is darkened in the middle and at the end, and bears two broad yellowish spots, one on each side, but this coloration is sometimes faintly developed, the scutellum being pellucid, perhaps as a result of immaturity. The punctuation of the frons is mostly not distinct; the thorax is entirely of a reddish colour, only the yellow mesopleural stripe being narrowly margined with black; the femora are yellow; in the wings the dark costal border is not complete, and even sometimes wanting, the first basal cell is entirely hyaline, and the anal stripe is not distinct.

The sexual characters of the male in the wing are the same as in *ferrugineus*.

Peradeniya, Ceylon (*E. E. Green*); Pusa, Bihar, on guava and sapodilla (*Achras sapota*) fruits, vi–vii.1914 (*T. B. Fletcher*); Coimbatore, in mango (*Mangifera indica*) fruits, vii.1913 (*T. B. Fletcher*).

7. **Chaetodacus zonatus,** W. W. Saunders (1841).

The following are synonyms of this species:—*squalidus*, Walker (1860); *persicae*, Bigot (1889); *mangiferae*, Cotes (1893), and Bezzi (1913).

In my paper of 1913 I have distinguished *zonatus* (with the synonym *persicae*) from *mangiferae*, which I considered to be a variety of *ferrugineus*. Now, after comparison of the types of *persicae*, Bigot, with those of *mangiferae*, Cotes, I have come to the conclusion that they must be referred to the same species; and as Saunders figures his *zonatus* as having an entirely reddish thorax, both the above-quoted names must be referred to it. *C. squalidus*, Walker, is evidently the same species, which is common in India, and very injurious to peach, mango and a number of other fruits.

The species which I have in 1913 interpreted as *zonatus* must be renamed, and I propose for it the name of *correctus*, n. n. The true *zonatus*, as here defined, is very like typical *ferrugineus* and probably only a variety of it, being distinguished by the different wing pattern. The wings have no dark costal border, but only a well defined, isolated black spot at the end; the first basal cell is altogether hyaline; the anal dark streak is wanting. Wing characters of male as in *ferrugineus*. Very characteristic for the species is the white-dusted band at the hind border of the second abdominal segment. The frontal spots are not distinct, and the facial black spots are much smaller than those of *ferrugineus*.

I have seen some specimens of the present species which show an abnormal tendency to have three or four scutellar bristles, but it is interesting to note that these supernumerary bristles are always apical, not basal.

I have seen numerous specimens, including paratypes of *Rivellia persicae*, Bigot, in the Indian Museum, labelled "the Ranchi peach-pest"; Pusa, Bihar, on peach (*Prunus persica*), vi.1914, on fig (*Ficus* sp. cultivated), iv.1914, on sapodilla (*Achras sapota*), vii.1914, and from ripe Bael fruit (*Aegle marmelos*), viii.1914 (*T. B. Fletcher*); Santikoppa, North Coorg, from fruits of *Careya arborea*, v.1914 (*T. B. Fletcher*); Amnoha, Moradabad, on mango fruits, vi.1914 (*T. B. Fletcher*); Pachmarhi, 3,500 ft., Central India, in peach fruits, vi.vii.1913, and Nagpur, in white gourd (*Lagenaria vulgaris*), viii.1913 (*Ratiram*); Taru, Peshawar Dist., bred from peach, viii–ix.1914 (*T. B. Fletcher*).

8. **Chaetodacus tuberculatus,** sp. nov.

The present species takes an intermediate position between the preceding, with which it has in common the two separated facial black spots, and the following one, with which it corresponds in the colour of the body. Eminently characteristic of it are the wholly yellow hind tibiae, which have a strong tubercle on the outside, before the end.

♂. Length of body, 6 mm.

Head as in *correctus*, with the same yellow bristles and only two pairs of lower fronto-orbitals, but the facial black spots are rather broad, rounded or ovate, larger than in *zonatus*, but not at all concurrent towards the middle; frontal dark markings less distinct. Thorax wholly black, also on the pleurae and on the breast; on the back it is greyish dusted, and around the humeral calli it is a little reddish; besides there are the following yellow markings:—humeral calli, a streak on each side behind the suture, a broad mesopleural band encroaching above on the sutural callus and prolonged below with a spot on the sternopleura, and two contiguous hypopleural spots. Scutellum entirely yellow, with narrow black base; mesophragma black, with a dark reddish, longitudinal middle stripe. Halteres pale yellow. Thoracic and scutellar bristles of a dark yellow colour, the scapular well developed, the anterior supra-alar strong, the pteropleural weak. Abdomen black, minutely punctulate, with short grey pubescence; third segment with black cilia; first and second segment more or less yellowish on the posterior half, and therefore at the base of the abdomen there is a more or less broad transverse yellow band, divided into two parts by a black transverse line, the posterior part being a little whitish. Venter and genitalia black. Legs rather short and stout, entirely yellow, even on the coxae,

with short yellowish pubescence; apical spur of middle tibiae black; pre-apical tubercle of hind tibiae very prominent; tarsi distinctly broadened at the end, with the basal joints not whitish. Wings hyaline, with yellowish veins, without a dark costal border, only the stigma being honey-yellow; a faint dark spot at the end of the third vein, often very little developed; last portion of fourth longitudinal vein curved at the base; first basal cell wholly hyaline, even in the narrowed part above the dilatation of the second basal cell; anal streak wanting, the point of the anal cell being only of a honey-yellow colour, like the stigma, but with a broad dark spot at the end; supernumerary lobe at the end of the anal vein well developed.

Type ♂ (British Museum) and some additional specimens of the same sex from Taung-gyi, 4,000 ft., and Myitkyima, Southern Shan States, in peach (*Prunus persica*), May to June (*T. B. Fletcher*).

9. **Chaetodacus correctus,** nom. nov.

Bactrocera zonata, Bezzi (*nec* W. W. Saunders), Mem. Ind. Mus., iii, 1913, p. 94, pl. viii, fig. 4.

Very near the true *zonatus*, but distinguished by the colour of the thorax, and chiefly by the facial black spots being united together to form a black transverse band. The whitish cross-band on the second abdominal segment is less developed. The hind tibiae of the male are distinctly tuberculate before the end.

This little species lives in company with the two preceding ones, feeding on the same fruits; it shows also some affinity with the following, *diversus*, Coq., but differs from it in many points of structure and coloration, which render impossible the suppositions advanced by Howlett in his interesting studies on the effects of citronella oil.* On the other hand, it is quite possible that *zonatus*, *tuberculatus* and *correctus*, all feeding on peach and all possessing the peculiar tubercle on the hind tibiae of male, are only different forms of a single species; but while *zonatus* and *correctus* are Indian, *tuberculatus* is found only in Burma.

The puparium of the present species is of a rather dark, shining yellow colour.

Pusa, Bihar, from peach (*Prunus persica*), 25.vi.1914 (*T. B. Fletcher*); Coimbatore, on mango (*Mangifera indica*), v.viii.1913 (*T. B. Fletcher*); Guindy, Madras, 16–21. viii.1913, "attracted to opened termitarium" (*T. B. Fletcher*); Hagari, Bellary District, Madras, on castor leaf, 14.viii.1909.

10. **Chaetodacus duplicatus,** sp. nov.

A rather small black species, very near the following, but distinguished by the four scutellar bristles and by the ciliated third abdominal segment of the male, and further differing from any other species recorded here on account of the double black facial band in both sexes.

♂ ♀. Length of body, 5–6 mm., with the ovipositor.

Head yellow, with striking black markings; occiput black, with a yellow border near the eyes, which becomes broader below; frons with a middle dark spot, a black ocellar dot, black lunula and three pairs of rather broad and well-defined black lateral spots; face shining, with two narrow, parallel, black cross-bands, the first a little

*Trans. Ent. Soc., London, 1912, pp. 412–418, pl. xxxix–xl.

below the base of the antennae, the second a little above the oral border; this latter band is placed in a furrow, and is often interrupted in the middle; dark subocular spot distinct; palpi pale yellowish; antennae entirely reddish yellow. Cephalic bristles black; only two pairs of lower fronto-orbitals present. Thorax entirely black, even on the pleura and breast, but clothed on the back with greyish pubescence; it bears the following bright yellow, very striking markings:—humeral calli, a streak on each side behind the suture, a broad mesopleural stripe united above with a very small sutural callus and below with a broad sternopleural spot, and two contiguous hypopleural spots. Scutellum entirely yellow; mesophragma entirely black. All the macrochaetae black; anterior supra-alar well developed; basal scutellar only a little weaker than the apical ones. Halteres whitish yellow. Abdomen rounded, punctulate, with short grey pubescence; third segment in the male with well developed black cilia; first segment with a narrow yellow hind border; second yellow, with a black basal band, which sometimes does not reach the sides; third and fourth entirely black; fifth yellow, with more or less distinct basal and middle longitudinal bands; ovipositor yellow, flattened, if exserted as long as the two last abdominal segments together; male genitalia brown; venter yellow, more or less darkened. Legs yellowish, with white hind praetarsi; coxae yellow; the four posterior femora with the tips dark brown; hind tibiae of male tuberculate, darkened at both ends or wholly blackish; last tarsal joints darkened. Wings hyaline, with dark yellow veins; male with the brown spot at the end of the anal vein and with the supernumerary lobe well developed, but less so than in *diversus*; no brown fore border and no distinct anal streak; only the stigma blackish brown, the subcostal cell yellowish brown at the end, and a well developed elongate brown spot at the end of the third vein; first basal cell wholly hyaline at the base; terminal portion of fourth vein curved at the base; no brown spot at the lower end of the hind cross-vein.

Type ♂ and type ♀ (British Museum) and some additional specimens of both sexes from Pachmarhi, 3,500 ft., Central India, on peach (*Prunus persica*), 30.v.1909 (*Ratiram*).

The present species belongs evidently to the group of *zonatus*, *tuberculatus* and *correctus*, feeding also on peach.

11. **Chaetodacus diversus**, Coq. (1904).

Bactrocera diversa, Bezzi, Mem. Ind. Mus., iii, 1913, p. 94, pl. viii, figs. 2–3.

Dacus sp., H. M. Lefroy, Indian Insect Life, 1909, pl. lxvi, fig. 2.

A very distinct species, the male of which has a non-ciliated third abdominal segment, but a very exaggerated supernumerary lobe at the end of the anal vein in the wings. The ovipositor is much longer than in the other species, very like that of *D. longistylus*; but in immature specimens it is flattened and apparently shorter. The facial band of the female is simple, not double as stated in my paper, probably as a result of confusion with *duplicatus*. The wing figures of pl. viii are those of the male (fig. 2) and female (fig. 3).

The puparium of this species is more whitish than that figured by Prof. Lefroy. The species was originally bred from oranges (*Citrus aurantium*). Pusa, Bihar, sitting on jaman leaves (*Eugenia jambolana*), 23.vi.1914, and on mustard, 27.i.1914

(*T. B. Fletcher*); Bangalore, on mango leaves, v.1913 (*T. B. Fletcher*); Machavaram, Godavari Dist., 26.xii.1913 (*T. B. Fletcher*); Coimbatore, ii. and ix.1912 (*T. B. Fletcher*); Nagpur, Central India, on white gourd (*Lagenaria vulgaris*), 14.viii.1909 (*Ratiram*); Dehra Dun, on grass, v.1912 (*Prof. A. D. Imms*).

12. **Chaetodacus maculipennis,** Dol. (1856).

Bactrocera maculipennis, Bezzi, Mem. Ind. Mus., iii, 1913, p. 99, pl. viii, fig. 11.

A very distinct species, which shows some affinity with the two preceding ones. It seems to be rare in India. The supernumerary anal lobe on the wings of the male is well developed.

Coimbatore, on cholam (*Andropogon sorghum*), 23.ix.1912 (*T. B. Fletcher*); Minbu, Lower Burma, on wild vine (*Vitis* sp.), 6–8.viii.1914 (*T. B. Fletcher*).

13. **Chaetodacus hageni,** Meij. (1911).

Dacus hageni, De Meijere, Tijds. Entom., liv, 1911, p. 375.

This species, described and recorded hitherto only from Sumatra, agrees with the preceding one in having four scutellar bristles and a middle yellow stripe on the thorax, but differs in having only two pairs of lower fronto-orbital bristles, two rounded facial black spots, and the brown fore border of the wings dilated into a broad spot at the end of the third vein. The male (hitherto undescribed) is very like the female, but has the third abdominal segment ciliated, the supernumerary anal lobe not much developed but distinct, and the anal streak less broadened at the end; the fourth abdominal segment shows a rounded yellow spot in the black pattern on each side.

A single male from Meiktila, Upper Burma, on gourd (*Curcurbita* sp., 13–15.viii.-1914 (*T. B. Fletcher*).

14. **Chaetodacus cucurbitae,** Coq. (1899).

Bactrocera cucurbitae, Bezzi, Mem. Ind. Mus., iii, 1913, p. 96, pl. viii, fig. 7.

Dacus cucurbitae, Lefroy, Indian Insect Life, 1909, p. 633, fig. 418.

This large and characteristic species is common in India and Burma, and very variable. The sexual characters in the male wing are well developed. The black facial spots are broad, ovate, and extended to the mouth-edge at their lower corner.

The following variations have been observed:—(*a*) *chaetotaxy*: sometimes only two pairs of orbital bristles; (*b*) *frontal pattern*: dark spots more or less developed, or even quite wanting; (*c*) *thoracic pattern*: thorax altogether reddish, or with black markings on the disk and the pleura; middle yellow stripe broad, narrow or even indistinct; (*d*) *abdominal pattern*: abdomen with none, or with one, or with two transverse black bands; (*e*) *femora*: entirely yellow or darkened at the end; (*f*) *wings*: anterior cross-vein not bordered with fuscous or with a narrow, or even with a broad border; posterior cross-vein broadly or narrowly bordered with fuscous.

Dehra Dun, on grass, vii, 1912 (*Prof. A. D. Imms*); Dhom, Krishna Valley, 2,400 ft., 29–30.iv.1913; some old specimens in the Indian Museum from Poona and Calcutta; Pusa, Bihar, on parol (*Trichosanthes dioica*) in March, in *Cucumis* fruits in October, in *Momordica charantia* fruits in January, in pumpkin fruits (*Cucurbita* spp.) in December, in *Luffa aegyptiaca* fruits in February and in December

(*T. B. Fletcher*); Lyallpur, Punjab, on bitter gourd (*Momordica charantia*), 24.x.1912 (*T. B. Fletcher*); Coimbatore, on melon and pumpkin (*Cucurbita melo, C. pepo*), and on cucumbers (*Cucumis*) (*T. B. Fletcher*); Nagpur, Central India, in cucurbit and in melon, v–vii.1910 (*Ratiram*); Taru, Peshawar Distr., larva in *Momordica charontia* (*T. B. Fletcher*); Meiktila, Upper Burma, on gourd (*Cucurbita pepo*), 13–15.viii.1914, Mandalay, on musk melon and on bitter gourd, 23.iv.1909, Pyinmana, on wild cucurbit, 7–9.ix.1914, Tatkon, on cucurbit, 6–7.ix.1914 (*T. B. Fletcher*), and many specimens from the last-named locality in fruits of *Trichosanthes cucumerina*, 20.ix.1914 (*K. D. Shroff*). All the specimens bred from fruits of *Luffa aegyptiaca* have the hind cross-vein very narrowly margined with fuscous.

15. **Chaetodacus caudatus,** F. (1805).

Bactrocera caudata, Bezzi, Mem. Ind. Mus., iii, 1913, p. 97, pl. viii, fig. 8.

A large species, and very distinct, owing to its four scutellar bristles, three pairs of lower fronto-orbital bristles and peculiar wing pattern. In the Indian specimens the wings have the hind cross-vein always in the condition described by Hendel for his var. *nubilus*; I have never seen specimens with that cross-vein entirely margined with fuscous, and I think that Wiedemann has mixed up the present species with the preceding one.

Dehra Dun, on grass, 16.v.1912 (*Prof. A. D. Imms*); Shevaroy Hills, 5,000 ft., 14–22.x.1912 (*T. B. Fletcher*); Coimbatore, on skaki gourd, 29.x.1908; Bababudin Hills, Mysore, 4–5000 ft., 2–12.xi.1912, a specimen with the femora broadly black at the end (*T. B. Fletcher*); Lashio, 3,000 ft., and Tatkon, Upper Burma, the larva in fruits of *Trichosanthes palmata*, viii–ix.1914, Myitkyina, on pomelo (*Citrus decumana*) 30.viii.1914, Taung-gyi, Southern Shan States, 4,000 ft., 1.iii.1910 (*T. B. Fletcher* and *K. D. Shroff*).

16. **Chaetodacus garciniae,** Bezzi (1913).

Bactrocera garciniae, Bezzi, Mem. Ind. Mus., iii, 1913, p. 97, pl. viii, fig. 9.

I have now seen other specimens of this species, bred at Peradenyia, Ceylon, from *Garcinia* fruits (*E. E. Green*).

This species has an isolated position in the present genus, and forms a link with the genus *Mellesis* owing to the face not being hollowed and the lack of the usual sexual dimorphism in the structure of the wing.

17. **Chaotodacus scutellarius,** sp. nov.

A very distinct species, strongly recalling *maculipennis*, Dol., but at once distinguished by the scutellum bearing only the apical pair of bristles and a well defined black spot at the end.

♀. Length of body (with the ovipositor), 6 mm.

Occiput shining black, with a broad yellow border, which is not dilated below; frons pale yellowish, white-dusted, darkened on the middle band but without a definite central spot, with three pairs of dark brown dots at the sides, the apical one of which is united with the dark lunula to form a transverse band above the root of antennae; ocellar spot shining black, and in contact with a black spot on each side, thus forming a transverse black band on the vertex; face pale yellow, shining, with

two oval black spots placed very low, in contact with the oral border; subocular dark spot distinct, but less defined; palpi and antennae yellow, the latter with the third joint darkened at the end; all the bristles are black, and there are three pairs of lower orbitals. Thorax entirely black, punctulate, grey pollinose on the back, with black bristles; middle scapular very thin, the outer strong; there is *no trace of an anterior supra-alar bristle*, but of this important point I am not sure, the specimen being unique; praescutellar well developed; pteropleural thin. The thorax shows the following bright yellow markings:—the humeral calli; a broad, exactly triangular mesopleural stripe, which terminates in a straight line above at the notopleural suture, the sutural callus being black, and is not continued below on the sternopleura, which is entirely black, with only a dark brown spot above; two contiguous hypopleural spots; three yellow stripes on dorsum behind the suture, the middle a little narrower than the lateral ones, all abbreviated long before reaching the scutellum. Mesophragma entirely shining black. Scutellum yellow, with the base narrowly black; at the apex there is a well defined shining black spot, which is sufficiently broad to fill the space between the bristles and is pointed anteriorly in the middle, reaching the middle of the scutellum. Halteres pale yellow. Abdomen black, punctulate, with grey pubescence like the thorax; first and second segment with an equal transverse yellow band on the hind border; third and fourth each with a small semi-lunar spot at the hind border on each side of the middle line; on the fifth segment these two spots are dilated so as to make almost the entire segment yellow, with a black middle line and a black base; basal segment of the ovipositor flattened, broad, as long as the last abdominal segment, black, dark reddish along the middle; second segment yellowish red; venter black, with a reddish basal band. Legs with the front femora almost entirely black, yellow only at the base and at the extreme tip; middle femora also black, but a little more broadly yellow at the base; hind femora with more than the basal half whitish, the remainder black; tibiae blackish, but the middle ones broadly pale in the middle; intermediate tarsi yellow, the others dark, with the praetarsi whitish; coxae brown. Wings hyaline, with dark yellowish veins; fore border narrow, but complete, blackish, extending from the stigma over the end of the third vein, where it is a little dilated, but not in the form of a spot; first basal cell broadly darkened above the second; a small dark spot at the end of the fifth vein and lower end of the hind cross-vein; anal streak broad and dark; last section of the fourth vein a little curved at the base.

Type ♀, a single specimen (British Museum) from Goorghalli Estate, 800 ft., S. Mysore, 14-24.iii.1913 (*T. B. Fletcher*).

18. **Chaetodacus biguttatus**, sp. nov.

An eminently characteristic species, distinguished from any other at present known by its scutellum being entirely black, with a small yellow spot on each side and bearing only the apical pair of bristles.

♂. Length of body, 5·5 mm.

Head with shining black occiput, which is margined with a rather narrow yellow border, which is arcuated below the vertical area and very little dilated below; frons pale yellow, but dark brown along the middle stripe and with three pairs of ill-defined dark spots at the sides; ocellar dot and lunula black; face shining yellow, with two

broad black spots on the lower half; subocular dark spot less distinct; antennae entirely yellow, the second joint with some short and one long bristly black hairs, the third joint rather short and a little attenuated towards the end; palpi yellow, much dilated at the end, the dilated part almost rounded; all the bristles black, three pairs of lower fronto-orbitals present, the two apical pairs being less approximated than usual. Thorax entirely black, punctulate, rather shining, chiefly on the pleura and breast; on the dorsum there is a greyish pubescence, which is longer than usual, and on the sides, humeri and pleura there are rather long and soft hairs of a pale yellowish colour; on the dorsum, seen from behind, there are two broad and distinct parallel stripes of grey dust, abbreviated behind, but not interrupted at the suture. All the bristles are black; middle scapular indistinct; anterior supra-alar and praescutellar well developed; pteropleural very thin. The yellow markings are rather small and as follows:—the humeral calli, but while in all the preceding species they are entirely yellow, in the present species they have a black border on the inner side; a very narrow streak on each side behind the suture; a narrow mesopleural stripe, not extended above because the sutural callus is quite black, and not prolonged on the sternopleura, which has only the upper border dark reddish brown; this mesopleural stripe is besides not dilated above on the notopleural suture, being almost of equal width throughout; two contiguous hypopleural spots. Mesophragma entirely black. Scutellum black, punctulate and pubescent like the dorsum, with a pair of strong, apical black bristles; the two yellow spots are very narrow, rounded, and placed on the extreme lateral angles, but decidedly dorsal; the inferior side of the scutellum is yellowish. Squamae pellucid, with a white fringe, halteres whitish yellow. Abdomen entirely black, punctulate and pubescent like the thorax, and with rather long pale hairs towards the base; first segment with a very narrow, linear, hardly distinct yellow hind border; second segment with a little broader yellow hind border, which is interrupted in the middle and does not reach the sides; fifth segment with a narrow yellow hind border, which is dilated above in the middle; venter and genitalia black; third segment with long black cilia at the sides. Legs with black coxae and trochanters; front femora almost entirely, the four posterior ones on the apical third, shining black; the four anterior tibiae yellow, hind tibiae black; all the praetarsi yellow, the four other joints more or less blackish; femora with rather long white hairs; middle tibiae with a black apical spur. Wings slightly yellowish hyaline, with blackish veins; no costal border, but the stigma black and the very narrow subcostal cell dark yellowish; a rather broad, isolated brown spot at the end of the third vein; a less distinct dark spot at the lower end of the hind cross-veins and at the apex of the fifth vein; anal cell altogether hyaline, no anal stripe and even the dark spot at the end of the anal vein rather small. Supernumerary anal lobe distinct, but less developed; last section of fourth vein curved at the base, but straight at the end.

Type ♂ (Indian Museum), a single specimen from Darjiling, 7,000 ft., 25.v.1910 (*Brunetti*).

19. **Chaetodacus bipustulatus,** Bezzi (1914).

Bactrocera bipustulata, Bezzi, Bull. Ent. Res., v, 1914, p. 153.

Allied to the preceding species but differing in its four scutellar bristles, the very

different coloration of the scutellum, and the entirely unicolorous wings. The humeral yellow spot is broadly margined with black at fore end and on inner side. Originally described from Mysore (Type in British Museum), there is another specimen from the same locality. Another male specimen in the Indian Museum from Coonoor, 6,000 ft., Nilgiris, vi.1912 (*Capt. Sewell*).

20. **Chaetodacus scutellaris,** Bezzi (1913).

Bactrocera scutellaris, Bezzi, Mem. Ind. Mus., iii, 1913, p. 98, pl. viii, fig. 10.

Allied to the two preceding species, but easily distinguished by the different coloration of the scutellum, by the middle postsutural yellow stripe on the thorax, and by the well developed anal brown streak on the wings. In the present species the yellow spot on the humeral calli is only margined with light brown (not black) at the inner fore corner.

Two females in the Indian Museum from Almora, 5,500 ft., Kumaon, xi.1912 (*C. Paiva*); Taung-gyi, S. Shan States, 4,000 ft., 1.iii.1910 (*K. D. Shroff*).

Note. It is interesting to see that, while in the Ethiopian fauna there is the unique *D. mesomelas*, Bezzi, from Congo and Ashanti, with a defined black pattern on the scutellum, in the Oriental fauna on the other hand there are so many species with patterned scutellum. Those known to me may be distinguished as follows :—

1 (8). Only two scutellar bristles.

2 (5). Only two pairs of lower fronto-orbital bristles; cephalic and thoracic bristles yellow; scutellar pattern less defined.

3 (4). Thorax in greater part black; scutellum with a darkish spot at the end; wings with anal brown stripe .. .. *incisus*, Walk.

4 (3). Thorax in greater part reddish; scutellum with two yellow spots; wings without anal stripe .. .. *versicolor*, n.

5 (2). Three pairs of lower fronto-orbital bristles; bristles black; scutellar pattern well defined.

6 (7). Scutellum yellow, with a black apical spot .. .. *scutellarius*, n.

7 (6). Scutellum black, with a small yellow spot on each side at base *biguttatus*, n.

8 (1). Four scutellar bristles.

9 (12). Two pairs of lower fronto-orbital bristles.

10 (11). Scutellum black, with two broad yellow spots; wings without brown markings .. .. *bipustulatus*, Bezzi.

11 (10). Scutellum yellow, with a black spot at the end; wings with a brown fore border, which is not dilated at the end .. .. *scutellinus*, n.

12 (9). Three pairs of lower fronto-orbital bristles.

13 (14). Wings with an isolated brown spot at the end of the third longitudinal vein; mainly black species, with black ovipositor and less developed middle yellow stripe on thorax .. .. *scutellaris*, Bezzi.

14 (13). The spot at end of the third vein is united with the brown fore border; ovipositor yellow.

15 (16). Yellow thoracic stripes less developed; black scutellar spot margined with red; brown fore border of wings not much dilated at end; abdomen of male with a complete basal black cross-band on third and fourth segment *sp. nov.* (not named).

16 (15). Yellow thoracic stripes very broad and striking; black scutellar spot not margined with red; brown fore border dilated into a spot at end; abdomen of male only with a black spot on each side on the third and fourth segment *scutellatus*, Hend.

C. scutellinus is a previously undescribed species from the Philippines, collected by Prof. C. F. Baker; the unnamed new species is from Japan (*Dr. Miyake*), but I have received it also from South China, Foochow (*Gardner*).

iv. MELLESIS, gen. nov.

In erecting my new genus *Monacrostichus*,* I provisionally comprised in it, besides the type species, the Oriental and Australian species *sepedonoides, aequalis, longicornis* (*vespoides*) and *conopsoides*; subsequently I described *M. crabroniformis* from India.†

At present I have before me very numerous species, which agree with *Monacrostichus* in having a stalked abdomen, a reduced thoracic chaetotaxy and elongate antennae; but they are different in having no acrostrichals, an interrupted suture, non-spinose front femora and the second section of the fourth longitudinal vein not sinuous. I now therefore think it is better to restrict the genus *Monacrostichus* to its type species *citricola*, and to erect for the other species a new genus, to which may be given the name of *Mellesis* (from the Greek *mellesis = delay*), in allusion to the fact that it is still to be decided which of the above-named species belong to it or not, and what is to be considered its relation to the genus *Callantra*. *Monacrostichus crabroniformis*, Bezzi (1914), is to be treated as the type of the genus *Mellesis*.

The new genus differs from *Chaetodacus* as follows:—First antennal joint as long as the second, the antennae being much longer than the face. No praescutellar bristles; anterior supra-alar bristles usually present, but sometimes wanting. Abdomen club-shaped. Wings without the supernumerary anal lobe in the male.

The known species are rather uniform in facies and wing pattern; they have a wasp-like appearance and seem to mimic certain Hymenoptera of the groups CRABRONINAE or EUMENIDAE. The species known to me may be tabulated as follows:

1 (4). No anterior supra-alar bristle; abdomen less stalked, being constricted only at base; fronto-orbital bristles well developed; face yellow, with a black stripe in each antennal groove, which reaches below the mouth border; hypopleural spot double; wings rather broad, with the second basal cell rather short.

2 (3). Frons broader than an eye, with only two pairs of lower fronto-orbital bristles; antennae much longer than the face, with the two basal joints elongated; wings yellowish, with a broad, rounded, apical blackish spot *sphaeroidalis*, sp. nov.

* Philippine Journal of Science, viii, 1913, p. 322.

† Bull. Entom. Res., v, 1914, p. 153.

3 (2). Frons narrower than an eye, with three pairs of lower fronto-orbitals; antennae not much longer than the face, with the two basal joints short; wings hyaline, with a broad apical grey and brown spot .. .. *brachycera*, sp. nov.

4 (1). Anterior supra-alar bristle well developed; abdomen properly stalked; face without black stripes in the antennal grooves; second basal cell long.

5 (6). Face entirely black; thorax with a single hypopleural spot and with a distinct yellow sutural stripe; anterior supra-alar bristle weak; wings with a dark fore border; smaller species .. .. *crabroniformis*, Bezzi.

6 (5). Face yellow, with or without more or less developed black spots or bands; anterior supra-alar bristles strong.

7 (10). No distinct lower fronto-orbital bristles; a single hypopleural spot; face almost immaculate; frons with a brown middle cross-band; femora reddish; wings narrow, with the second basal cell much longer than broad and with an even brownish-yellow fore border extending to the third vein but not dilated at the end; size larger.

8 (9). Apical spot of the marginal cell entirely brown; yellow markings on thorax and scutellum well developed; ovipositor conical .. .. *destillatoria*, sp. nov.

9 (8). Apical spot of the marginal cell hyaline towards the middle; yellow markings less distinct; ovipositor flattened .. .. .. *eumenoides*, sp. nov.

10 (7). Two pairs of well developed lower fronto-orbitals; hypopleural spot double; face with black spots or black band; frons not banded, only with a middle brown spot; femora in part black; second basal cell less elongate; size smaller.

11 (12). Face with a black transverse band; thorax on dorsum and pleura mainly black; all the femora in greater part black; wings with the black fore border narrow, almost undilated at end .. .. *pedunculata*, sp. nov.

12 (11). Face with two broad, ovate black spots; thorax in great part reddish; the four posterior femora entirely yellowish; wings with the dark fore border dilated into a broad rounded spot at end .. .. *nummularia*, sp. nov.

The last two species are from the Philippines (*Prof. C. F. Baker*), and will be described at another opportunity; all the remainder are from India or Burma.

21. **Mellesis sphaeroidalis,** sp. nov.

A very distinct species on account of the shape of its abdomen, the want of the anterior supra-alar bristle, and the wing coloration. The present and the next following species are not typical for the genus *Mellesis*, owing to their reduced chaetotaxy and not properly stalked abdomen, which is only constricted and depressed at the base, not at all in shape of a cylindrical thin stalk.

♂. Length of body, 10 mm.; length of antenna, 2 mm.

Head entirely reddish yellow; occiput rather shining, with a pale yellowish border near the eyes; ocellar dot small, black; frons very broad, distinctly broader than an eye, more dark towards the middle, and rather opaque; the orbital bristles are placed on small brown dots, one upper and only two lower pairs; lunula pale yellow, glistening; face pale yellow, shining, with a black stripe along each antennal groove, which below reaches the mouth-border, and above is prolonged in a thin point to the root of the antennae; cheeks narrow, yellow, rather opaque, like the jowls, which

have a brown spot below the lower corner of the eyes. Antennae much longer than the face, entirely yellow; first joint porrect, only a little shorter than the elongate second joint, which is pendulous like the third; third joint a little shorter than the first two together, slightly attenuated but obtuse at the end; the bare, very thin, yellow arista is inserted near the base and is as long as the last two joints together. Palpi broad, yellow, with very short pale hairs; proboscis dark brown, with yellowish pilose flaps. All the bristles of the head are black. Thorax entirely reddish, densely punctulate, with short yellowish pubescence, there are the following yellow markings: entire humeral callosities, but less bright than the other markings; sutural calli; a broad stripe on the mesopleura, which is broadly margined with black in front and is not continued on the sternopleura; two contiguous hypopleural spots. Suture broadly interrupted in the middle. Scutellum entirely yellow, with a narrow brown band at base; mesophragma reddish, without black markings. All the bristles are black; exterior scapulars long and strong, interior very thin, like yellow hairs; it seems that the anterior notopleural is wanting, like the anterior supra-alar; mesopleural thin; pteropleural indicated only by a yellowish hair; scutellum with only an apical pair of strong bristles. Halteres whitish. Abdomen club-shaped, rather narrow at base, but not in the shape of a cylindrical stalk; it is clothed with rather long whitish pubescence, which becomes yellowish and sericeous on the posterior segments, and is very long at the sides of the first two segments; it is punctulate like the thorax; first and second segment entirely reddish, the second with a broad yellow hind border; third segment with black cilia at the sides, dark red, with a broad black basal band, which does not reach the sides; fourth reddish, becoming yellowish towards the hind border; fifth red in the middle, black at the base, yellowish behind, with the two foveiform patches rather distinct. Venter reddish, pale yellowish before the end of the second sternite, the last two sternites with a broad black middle spot, the penultimate being smaller; genitalia small, reddish, retracted. Legs entirely reddish, but the basal half of the hind femora and all the tarsi (except the end) pale yellowish or whitish; the short pubescence is pale yellowish; the terminal spur of the middle tibiae is long and black. Wings with a yellowish tinge, which becomes more pronounced along the fore border above the third vein, but the second basal cell is almost hyaline and the alula is quite vitreous; no distinct supernumerary axillary lobe; the blackish brown spot is almost circular and extends from the end of the second vein to the upper corner of the discoidal cell and a little before the middle of the second posterior cell; the anal cell is distinctly yellow at the base and has a diffused dark spot at the end. Middle cross-vein very long and S-shaped; last section of third vein bent backwards before its middle; last section of fourth vein short and gently curved.

Type ♂ (British Museum) a single specimen from Dehra Dun, 16.vii.1912, on grass (*Prof. A. D. Imms*).

22. **Mellesis brachycera,** sp. nov.

A rather aberrant species, apparently allied to the preceding, but distinguished from it and from all the others on account of the short basal joints of the antennae, which are shaped almost as in *Bactrocera*, while the chaetotaxy is that of *Dacus*, *s. str.*

♀. Length of body, 8 mm.

Head entirely reddish yellow; occiput without a pale border around the eyes, or only with trace of an indistinct one at the lower part; ocellar dot black; frons narrower than an eye, much narrower than in the preceding species, with a less distinct dark spot in the middle or on the sides at the insertion of the orbital bristles; three pairs of lower fronto-orbitals; lunula small, shining reddish; face, cheeks and jowls as in the preceding species, but the black stripes in the antennal grooves are shorter, reaching above only to the middle of the face; there is a weak but distinct genal bristle, which is entirely wanting in *M. sphaeroidalis.* Antennae entirely yellow, only a little longer than the face, the two basal joints not being elongated and the first being much shorter than the second; third joint elongate, with parallel sides, obtuse at end; arista bare, thin, yellow, longer than the whole antenna. Palpi and proboscis as in the preceding. All the bristles of the head are black, like those of the thorax and scutellum; in the case of the type there are two outer vertical bristles on the left side, the supernumerary one being as strong as the normal and closely approximated to it. Thorax as in the preceding species, but the humeral calli are more reddish than yellow, and behind the suture there is a blackish patch on each side, margined outwardly with a less defined yellowish stripe; the suture is broadly interrupted in the middle and the sutural calli are reddish yellow; mesopleural stripe reddish yellow, broadly margined with black in front, and shortly continued below on the upper part of the sternopleura, which is black (not reddish, as in *sphaeroidalis*); hypopleural spot double; a small black spot above the hind coxae; mesophragma with a broad black stripe on each side. Halteres and scutellum as in preceding, but this last is less bright yellow. Chaetotaxy as in *sphaeroidalis*; middle scapular long and yellow, exterior black; the anterior supra-alar is likewise wanting, but the anterior notopleural is as well developed as the posterior one. Abdomen elongate, not properly stalked, only narrowed near the base; pubescence as long as in *sphaeroidalis*; coloration also similar, but the second segment bears a transverse ovate black spot near the base, and the fourth and fifth have a black spot-like stripe on each side near the base. Venter yellow, with black middle spots on the hind half; basal joint of ovipositor broad, in the shape of a trapezium, flattened, yellow, with long pubescence. Legs as in the preceding species, but the basal half of the middle femora is whitish. Wings hyaline, without yellow tinge; fore border only pale brownish to the third vein; apical spot as in the preceding, but of a grey colour, with two dark stripes along the third and fourth veins, the first being twice as broad as the second; anal cell without dark stripe, only with a dark yellowish base; small cross-vein straight.

Type ♀ (British Museum) a single specimen from Dehra Dun, Bhimtal Kumtal, 10.vi.1912 (*Prof. A. D. Imms*).

23. **Mellesis crabroniformis,** Bezzi (1914).

Monacrostichus crabroniformis, Bezzi, Bull. Ent. Res., v, 1914, p. 153.

A very characteristic species on account of its small size, entirely black face, weak anterior supra-alar bristle and single hypopleural spot. Originally described from Yerkaud, Shevaroy Hills, and not seen subsequently; type in the British Museum.

24. **Mellesis destillatoria,** sp. nov.

A species of greater size, and readily distinguished by the almost unspotted yellow face, well developed anterior supra-alar bristle, simple hypopleural spot, properly stalked abdomen and conical ovipositor.

♀. Length of body, 10 mm.; length of antenna, 2·5 mm.; length of ovipositor 2 mm.

Head yellow; occiput with a broad pale border behind the vertex and along the eye borders; ocellar area broadly variegated with brown; frons broad, distinctly broader than an eye, with a black cross-band in the middle, prolonged behind into a point on each side; lunula shining black above; a fuscous ill-defined stripe on the dividing line between the frons and cheeks; face broad, rather shining, with uncertain fuscous spots above, below the root of the antennae and on the inner border of the antennal furrows behind the middle; a narrow black border at the upper mouth edge; cheeks and jowls yellow, the latter with a black triangular spot under the eye; genal bristle distinct; fronto-orbital bristles wanting in the case of the type, but it seems that the single upper pair may be present, the lower pairs being entirely wanting. Antennae very elongate, much longer than the face, yellow, the third joint darkened and with whitish dusting; first joint elongate, about as long as the second; second joint dilated at the end, with some pale yellowish hairs above and a longer one near the middle; third joint a little longer than the first two taken together, linear, a little broader before the end than near the base, obtuse; arista thin, bare, dark yellowish, as long as the last two antennal joints. Palpi broad, yellow, black at base, bare; proboscis black, with yellowish flaps and with long pale hairs. Thorax short, convex, punctulate, entirely of a reddish colour, with short greyish pubescence; there is a narrow longitudinal black middle stripe, ending before the scutellum, and in front with a trace of a lateral black stripe on each side; suture broadly interrupted in the middle, with a narrow yellow stripe on each side, which, becoming broader and passing over the sutural calli, encroaches on the mesopleura, ending a little beyond the upper border of the sternopleura; this stripe is margined with black in front on the mesopleura; sternopleura above and pteropleura entirely black; humeral calli yellow, narrowly margined with brown in front; a single hypopleural spot, the mesophragma being reddish, with a blackish stripe on each side, which is only narrowly paler on the upper border. Scutellum yellow, with a black basal band. All the bristles are black; interior scapular black and as strong as the exterior; anterior notopleural and anterior supra-alar both well developed; pteropleural not distinct; apical scutellar strong. Halteres whitish. Abdomen with the first segment constricted to form a thin cylindrical stalk, continued by the base of the second segment, which is broadened behind; the other three segments form an almost spherical club, under the border of which projects the strong and swollen ovipositor, with a long and conical first segment; the abdomen is punctulate like the thorax and has a whitish pubescence, which is longer at the sides and becomes sericeous and yellowish on the last two segments. First segment reddish yellow, with a brown spot above on the posterior half; second dark reddish, with yellow fore angles and a broad pale yellowish hind border; third blackish, with a complete reddish hind border; fourth and fifth black, with a broad yellowish hind border, which is broadened towards the middle; the shining oval patches of the

last segment are broad and placed obliquely; ovipositor reddish brown, with the second segment lighter; venter black, with yellow base. Legs entirely reddish brown, with whitish pubescence; the base of the four posterior femora and the four posterior praetarsi are pale yellowish; apical spur of middle tibiae long and black. Wings rather narrow, greyish hyaline, with a brown yellowish fore border, which surpasses a little the third longitudinal vein, and is darker brown in the part below this vein and in the apical part above the end of the second longitudinal vein. Along the anal cell there is a broad but faint pale yellowish streak. Small cross-vein straight; last sections of third and fourth longitudinal veins almost straight and parallel.

Type ♀ (author's collection), a single specimen from Bhamo, Burma, vii, 1886 (*L. Fea*); cotypes in the Museum Civico, Genova.

25. **Mellesis eumenoides,** sp. nov.

Nearly allied to the preceding species, and perhaps only a variety of it, but distinguished by the flattened ovipositor, well developed upper fronto-orbital bristles, and different pattern of body and wings.

♂ ♀. Length of body, 10 mm.; length of antenna, 2·5 mm.; length of ovipositor, 2 mm.

Head and its appendages as in *M. destillatoria*, but with the following differences. There is no complete blackish cross-band on the frons, but only a less distinct dark middle spot; the face is entirely reddish yellow, with only a small black spot on each side near the upper end of the antennal furrows; mouth-edges without a black border; upper pair of fronto-orbital bristles thin but distinct, but the three lower pairs seem to be deciduous, being wanting or represented only by hairs. Thorax and scutellum as in *destillatoria*, but the yellow markings are much less distinct, being of a reddish colour, only a little paler than the colour of the surrounding parts. Abdomen shaped, coloured and clothed as in *destillatoria*; third segment of male with well developed black cilia, the genitalia in the same sex black, retracted; ovipositor with the basal segment flattened and black below, the second segment yellowish. Legs paler than in the preceding species. Wings with the same pattern and the same neuration; but in the brown end of the submarginal cell there is a hyaline streak, which is wholly wanting in *destillatoria*.

Type ♂ and ♀ (British Museum) and another male specimen from Takton, Upper Burma, 6–7.ix.1914, bred from fruits of *Trichosanthes cucumcrina*, excl. 20–21.ix.1914 (*K. D. Shroff*). An additional male specimen from Myitkyina, Upper Burma, excl. ix.1914, from cucumber (*T. B. Fletcher*).

The puparium of the present specices is of a pale whitish yellow colour, opaque, with less marked segmentation; posterior spiracles approximated, on a rounded blackish area.

v. Monacrostichus, Bezzi (1913).

As stated above, this genus is now restricted to its type species *M. citricola*, because I do not know if the species attributed to it in the Philippine Journal of Science belong in reality to it, or to *Mellesis*, or to some other genera. To the characters of the genus must be added that the thoracic suture is complete, thus indicating perhaps affinity with the genera *Adrama* and *Meracanthomyia*. Lower fronto-orbital bristles

entirely wanting, thus showing relation with *Mellesis destillatoria*. Second basal cell much longer than broad, thus showing remoteness from *Chaetodacus* and *Dacus* (*s. str.*).

vi. CALLANTRA, Walker (1860).

This genus is unknown to me; Hendel* has it (as *Calantra*) among those with unarmed femora. It is very probable that this genus may coincide with one or the other of the two preceding genera; but Walker says: " Antennae long, seated on a common petiole or first joint, with which the succeeding part forms a right angle." Until it is proved that this is an error of observation, we must consider the genus as a distinct one. The type species, *C. smicroides* (*smieroides*) is from Makassar.

vii. NEOSOPHIRA, Hendel (1914).

This genus also has not yet been found in India. It has the general facies of *Adrama*, but is distinguished by the interrupted thoracic suture and by the unarmed femora. This and the two following genera belong to a special tribe, which is very different from the true DACINAE, as is to be seen from the narrow elongate body, the plumose arista, the elongate and triangular scutellum, the elongate and thickened middle femora, the narrow second basal cell and the short point of the anal cell. The two following genera have besides a complete, uninterrupted thoracic suture and spinose femora.

viii. ADRAMA, Walker (1859).

This genus is of economic importance, one of the species being the so-called tea-seed fly (*A. determinata*, Walk.), which, as observed in West Java, has done much damage in destroying tea-seeds (*Meded. v. h. Proefstation voor Thee*, xxxv, March 1915). Three species are at present known, only the following being Indian.

26. **Adrama austeni,** Hendel (1912).†

Very near *A. determinata*, but distinguished by the black occiput and by the much narrower apical dark spot of the wings.

Originally described from Ceylon, I have seen a male specimen collected at Peradeniya, by Prof. Buguion.

ix. MERACANTHOMYIA, Hendel (1910).

Very near the preceding genus, but differing in the very elongate antennae, which are shaped as in *Monacrostichus*, in the compressed, not depressed, ovipositor, the short face, the produced mouth-border, and in the middle femora being spinose for their whole length. Two Indian species of the present genus are known: *M. maculipennis*, Macquart (1851), from East India, and *M. gamma*, Hendel (*Wien. ent. Zeit.*, xxix, 1910, p. 107, pl. 1, fig. 13) from Ceylon. A third species, *M. antennata*, Hendel (*Wien. entom. Zeit.*, xxxi, 1912, p. 11) from Ashanti, West Africa, is the unique representative of the present tribe in the Ethiopian region.

**Wien. Ent. Zeit.*, xxxiii., 1914, p. 74.
†*Wien. Ent. Zeit.*, xxxi, p. 12.

INDEX OF PLANTS, WITH THE SPECIES FEEDING ON THEM.

Achras sapota	Chaetodacus ferrugineus versicolor, C. zonatus.
Aegle marmelos	Chaetodacus zonatus.
Andropogon sorghum	Chaetodacus maculipennis.
Artocarpus integrifolia	Chaetodacus ferrugineus incisus.
Calotropis procera	Dacus longistylus.
Capsicum frutescens	Chaetodacus ferrugineus dorsalis.
Careya arborea	Chaetodacus ferrugineus incisus, C. zonatus.
Citrus aurantium	Chaetodacus diversus.
Citrus decumana	Chaetodacus ferrugineus, C. ferrugineus dorsalis, C. caudatus.
Citrus sp.	Monacrostichus citricola.
Cucumis sp.	Chaetodacus cucurbitae.
Cucurbita melo	Dacus brevistylus, Chaetodacus cucurbitae.
Cucurbita pepo	Chaetodacus cucurbitae.
Cucurbita sp.	Chaetodacus hageni, C. cucurbitae, C. caudatus.
Eriobothrya japonica	Chaetodacus ferrugineus, C. ferrugineus dorsalis.
Ficus sp.	Chaetodacus zonatus.
Garcinia sp.	Chaetodacus garciniae.
Lagenaria vulgaris	Chaetodacus zonatus, C. diversus.
Luffa aegyptiaca	Chaetodacus cucurbitae.
Mangifera indica	Chaetodacus ferrugineus, C. ferrugineus dorsalis, C. ferrugineus incisus C. ferrugineus versicolor, C. zonatus, C. correctus.
Momordica charantia	Chaetodacus cucurbitae.
Prunus persica	Chaetodacus ferrugineus, C. ferrugineus dorsalis, C. zonatus, C. tuberculatus, C. correctus, C. duplicatus.
Psidium guyava	Chaetodacus ferrugineus, C. ferrugineus dorsalis, C. ferrugineus incisus, C. ferrugineus versicolor.
Pyrus communis	Chaetodacus ferrugineus dorsalis.
Solanum verbascifolium	Chaetodacus ferrugineus dorsalis, C. ferrugineus incisus.
Thea sp.	Adrama determinata.
Trichosanthes cucumerina	Chaetodacus cucurbitae, Mellesis eumenoides.
Trichosanthes dioica	Chaetodacus cucurbitae.
Trichosanthes palmata	Chaetodacus caudatus.
Vitis sp.	Chaetodacus maculipennis.

Note.—From the above enumeration it will be seen that the forms of *C. ferrugineus* and its allies breed on various plants of different families, but never on Cucurbitaceae; while *C. cucurbitae* and its allies feed only on plants of that family. The polyphagous species, like *C. ferrugineus* (*s. l.*) and *C. cucurbitae*, are very variable in their characters. Only species or forms of the *ferrugineus*-group are attracted by oil of citronella.

NOTES ON AFRICAN CHALCIDOIDEA—V.

By JAMES WATERSTON, B.D., B.Sc.,

Imperial Bureau of Entomology, London.

Eupelminus tarsatus, Waterst. (1916).

Eupelminus tarsatus, Waterston, Bull. Ent. Res., vi, Feb. 1916, p. 389, figs. 7 and 8; Lamborn, ibid., vii, May 1916, p. 34.

A series of both sexes of this parasite of *Glossina morsitans* enables me to describe the male for the first time and the female more fu'ly. One of the striking features about this species, apart from its remarkable sexual dimorphism, is the great range in size which it exhibits. The females run from 3½ mm. to 5 mm. and the males from 1½ mm. to 2¼ mm., with a range in the alar expanse of 2¼ mm. to 3¾ mm. The larger female examples are invariably darker and more metallic in coloration. Dr. Lamborn is certainly right in correlating the smaller size of some of the parasites with a reduced food supply (*l.c.* p. 35). I cannot yet agree, however, that the parasitic status of *E. tarsatus* is definitely fixed by our present knowledge of its habits. Plainly the proportion of *Mutilla*-parasitised puparia supplied to the *Eupelminus* females was larger than could have occurred under natural conditions. Again, the factors, whatever they are, inducing *Mutilla* to oviposit in a particular puparium may be equally decisive for the female *Eupelminus*. If, for example, in two cases three *Eupelminus* punctures all close together could be seen with a high-power lens one might suggest that some structural peculiarity invited the attack. Nor, incidentally, is it legitimate to infer that because a puparium observed to be stung produced no *Eupelminus* the attack had failed. The presumption is that the attack had not been delivered, stinging and ovipositing being, in many cases, two separate processes. Many Chalcids plunge the ovipositor into ova, puparia, etc., and then, applying the mouth to the wound, suck up the contents which have been expelled. In other cases the first stinging observed is merely the narcotising and rendering antiseptic of the host, which precedes the real introduction of the ova. The parasitic status of *Eupelminus* can, in fact, be settled only by examination of puparia, collected under natural conditions, from which the Chalcids have been noted to emerge.

Additional Notes on the Female.

The most interesting fact revealed by Dr. Lamborn's new material is that the female is sub-apterous. Examination of a number of specimens shows that in some the fore wing (fig. 1) is present, in others the wing has broken off at the apex of the axillary sclerite, while in others again the rupture has taken place below the tegula itself. I am convinced now that the sclerite referred to in my original description (*l.c.*, fig. 8, T) is not the tegula but the exceedingly elongated axillary scutum which fits into a groove running along the upper edge of the mesopleura. The hind wings, which are minute, fit into a similar depression of the metanotum. The axillary

scutum referred to is always, as far as I have seen, fixed, and the fore wing appears to originate posteriorly from the side of the scutellum at the level of the apex of the axilla (fig. 2). Dr. Masi has (*in litt.*) pointed out how closely *E. tarsatus* approaches in important characters to *Eupelmus degeeri*, Dalm., and suggests that a new genus should be erected for the reception of these species.

In *degeeri* there is a line of weakness at the point where in *tarsatus* the wing is truncated and it may be that in freshly emerged examples *tarsatus* possesses the additional alar flap present in *degeeri*.

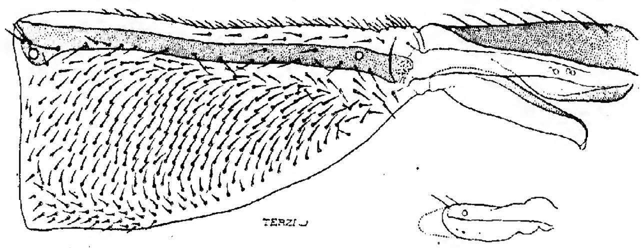

Fig. 1. Wings of *Eupelminus tarsatus*, Wtrst., ♀.

Description of the Male.

♂. A black or dark brown species, only the first three tarsal joints of the mid and the first two of the hind legs distinctly white. Antennae blackish, with the base and the inside of the scape brownish, and in some lights traces of metallic lustre on the apex of the scape. On face, vertex and genae some dark greenish or cupreous reflections. Thorax like head, propodeon and base of abdomen dark shining blue, remainder of abdomen duller cupreous. Femora and tibiae, except indistinctly and shortly at the base, blackish with dull dark blue reflections on hind femora; fore tarsi fuscous, fourth and fifth tarsal joints of mid legs and third to fifth of hind legs black.

Head from in front rounded, as broad as long. Eyes with a short scattered pubescence extending over about two-thirds of the depth in profile, the depth of the eye being about twice the shortened genal space; at their nearest point across the frons the eyes are separated by 1½ diameters. Toruli reniform, narrower superiorly, more than half below the base line of the eyes, with about 40 minute bristles on the raised triangular area between the scapal grooves; the latter bare, all the rest of the frons and the vertex covered with short bristles; orbital bristles not differentiable. Clypeus smooth, regularly convex, with one shorter and one longer bristle above at each side somewhat remote from the edge. The whole reticulation is fine, regular and evenly raised on vertex, but becoming more scaly towards the mouth-edge. As compared with the female head, that of the male is shorter, the eyes approximated nearer the mid frons and not superiorly, the depressed area between the scapal grooves not so sharply limited laterally, and the toruli higher in position. Mouth-parts essentially as in female. The mandible is more suddenly contracted apically. The first two joints of the maxillary palpi are in the same ratio, the third is slightly shorter and the fourth distinctly so, while two and three of the inner sub-apical bristles are much stouter in the male.

Antenna: length 1·25 mm. in an example whose fore wings are 1·35 mm., 11-jointed, the club being solid, one ring joint and seven normal in funicle. Scape narrowed on basal third and at its widest (1 : 3) near the apex, barely as long as the first three normal funicular joints, nearly twice as long as the club (12 : 7) and of the same breadth. Pedicel (8 : 3) slender basally, three-eighths of the scape. All funicle joints slender, cylindrical, sub-equal (9, 8, 9, 9, 8, 8, 8) and the club in the same scale 13. Average breadth 5, of the club 6. Joints 6 and 7 are distally more distinctly articulated. The sensoria are numerous, long and narrow, with very short free points.

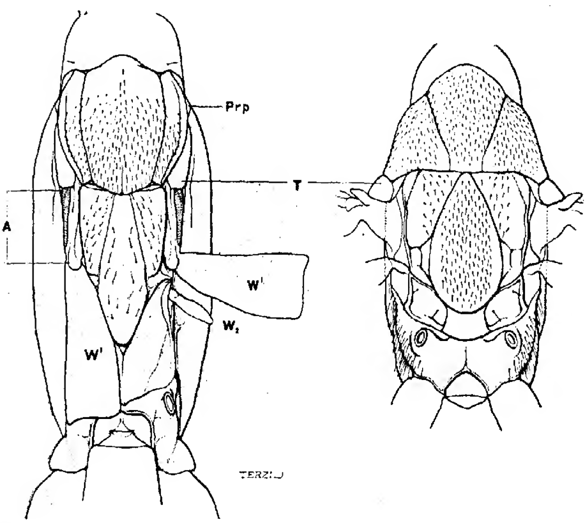

Fig. 2. Thorax of *Eupelminus tarsatus*, ♀ (left) and ♂ (right); A, axillary scutum; T, tegula; W^1, fore wing; W_2, hind wing; Prp., prepectus.

Thorax: When flattened out the pronotum is a little concave posteriorly, but deeply and broadly so in front. The spiracle lies *in front* of the lateral angle, and the posterior row of bristles contains about 12. The pattern is fine and much raised, with numerous regularly disposed short bristles. The prosternum is posteriorly so broadly truncate as to be nearly triangular in outline. Two longer central (1 : 1) bristles lie nearly on the posterior edge with 24 (12 : 12) other stouter bristles over the surface. Mesonotum a little flattened, the parapsidal furrows fading posteriorly, but in a mounted example traceable to the suture and meeting the anterior edge of the axilla before one-half. Axillae very narrowly separate (see fig. 2). Whole surface densely set with bristles, raised reticulate, the pattern finest in the mid lobe and coarsest on the axillae. Prepectus large, with a bold but little raised pattern, found also on the episternite and large oblong epimeron. Below the episternite there is a thin clear track in the chitin, reaching back below the epimeron, and meeting with it posteriorly is a similar broad line from the inner angle of the prepectus. The triangular area thus delimited bears about 30 bristles, and there are about as many

more on each side of the mid line of the sternum. The latter is posteriorly deeply and rather narrowly emarginate in the middle. Metanotum strongly raised reticulate, especially on the post-scutellum. Propodeon smooth between and behind the oval outwardly directed spiracles. Below and behind the spiracle the pleurae are densely covered with bristles. The sulci running round the spiracles outside broaden as they pass inwardly, being at their nearest point one-third of the distance of the spiracles from one another.

Wings: Fore wings more than twice as long as broad. Sub-marginal : radius : post-marginal, as 10 : 6 : 3 : 4. Fringe short, discal ciliation everywhere evenly set, except along the hind margin near the base up to the middle of the frenulum. There is a bare spot in the middle of the basal triangle just before the uprise of the marginal. About 20 bristles on the marginal. Hind wings, 4 : 1.

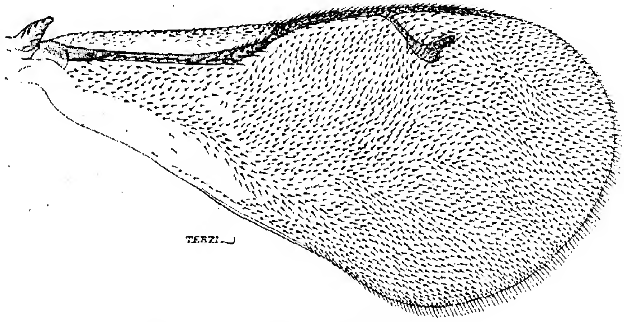

Fig. 3. Fore wing of *Eupelminus tarsatus*, ♂.

Legs: Fore legs: the upper apical angle bears two short teeth or peg-like spines, the apical comb 5–6 spines. The comb on the first tarsal joint (16 spines) is continued along the antero-ventral edge of the joint to the apex by a row of 5–6 spinose bristles. At the apex of the mid femur there are anteriorly, 4, posteriorly, 1, spinose bristles. Hind coxae elongate (2 : 1), apical comb of tibia containing 9 strong bristles. In all the tarsi the proportions are much alike and hardly different from those of the female. The first is about twice the second, which exceeds the third, which is equal to the fifth, and the fourth is shortest.

Sycophaga cyclostigma, sp. nov.

Head (10 : 9) flattened oblong, with prominent and entirely glabrous eyes which are separated by rather over twice the diameter of either, and extend respectively over one-half of the lateral margin. Vertex with a wide, V-shaped depression, forming at the side two distinct posterior angles behind the eyes. Posterior ocelli (oval) on vertex, anterior (circular) on frons, well within the post-scapal groove. Toruli oval, ventrally truncate, convergent superiorly towards the mid line of the frons and narrowly separated, set above mid way between the base line of the eyes and the clypeal edge, but clear of the former. The latter with a median tooth set in a shallow hollow which hardly exceeds the flat low lobes by which it is flanked. On each side

of the median tooth are one long and one short bristle; above the clypeal edge the face is broadly bare; there are one or two bristles below the toruli, and none between; while on each side of the face are 40–50 similar minute irregularly-disposed bristles.

Antenna: length, ·75 mm.; scape (7 : 2), with subparallel sides, constricted near the base; rather bare, and with minute bristles of which two, very short and appressed, are ventral at one-third and two-thirds respectively; pedicel (5 : 3) barely one-half of the scape; first ring joint about half as long as the second. The joints of the funicle are subequal, but the first is one-fifth less, and the fourth one-eighth longer than the others; the first segment of the club equals the last funicular in length, and the three segments are in the ratio 5 : 4 : 5; the third segment shows a minute apical subdivision—probably a sense organ—which bears only bristles. The breadth of funicle and club is uniform, the joints being approximately as long as broad, except the first funicular, which is a little narrower. The first funicular bears four sensoria, and the second six, as does also the last segment of the club; the other joints bear eight to twelve.

Mouth-parts: mandibles broad, triangular, with inwardly curved apex; about ten bristles on the apical outer half. Inner edge with two teeth, the distal angular, the more proximal rounded. Maxillary palpus very short, single-jointed, with only two terminal clear minute spines. Labial palpi relatively large, two-jointed, in the proportion 11 : 7; second joint about twice as long as the maxillary palpus. The first has one external, and the second two apical spinose bristles. There are apparently no cell-like structures on the lingua, whose distal edge is merely frayed.

Thorax: prothorax smooth, except on the overlaps (below the spiracle) which are reticulate. Spiracles projecting, with some minute bristles, just behind on the inside, and many more in front in a broad antero-medianly interrupted band; no posterior row of longer bristles. The narrow sternite smooth, and the episternite raised reticulate. Mid lobe of mesonotum smooth and bare, save for two or three short bristles inside the furrows near the suture. Lateral lobes and axillae with two or three short bristles, smooth, except towards the lower edge of the axillae, which is faintly reticulate. Scutellum oblong, nearly quadrate, with concave sides and about eighteen minute bristles (9 : 9); mesophragma deeply bifid apically, exactly the length of the propodeon. The large tegulae, the distinctly separated prepectus, and the sternum anteriorly, are coarsely reticulate and slightly raised. The remainder of the sternum and the episternal sclerite smooth. Metathorax: both the post-scutellum and the side areas are raised reticulate.

Propodeon smooth, with traces of raised pattern outside and below the spiracle, where are also two to three short bristles. The propodeon bears also postero-laterals patches of about a dozen bristles each.

Wings: Fore wings twice as long as broad; length, 1·55 mm.; breadth, ·72 mm. Submarginal: marginal: radius: post-marginal, as 4 : 1 : 1 : 2. The apex of the post-marginal is hyaline, so that the vein appears (unless carefully examined) to be shorter than it is; the apparent ratio with the marginal being about 5 : 3. The basal half of submarginal cell and the wing base to below the uprise of the vein are bare. Wing ciliation regular, no hairless lines. In all the specimens examined the submarginal vein bears five bristles on the basal two-thirds, and two more (after a distinct gap) before the pair of pustules at the uprise. There are about 24 bristles

projecting beyond the costa along the marginal and post-marginal combined, and the radius has four-five bristles and three cells. Hind wings rather over three times as long as broad; length, 1 mm.; breadth, ·3 mm.; the submarginal cell narrow and long (the venation extending to nearly seven-tenths of the costa), with a single row of minute bristles on the apical two-fifths.

Legs: Fore legs: coxae elongate (two-thirds of the femur and one-third longer than the tibia), oblong (2 : 1), a little broader basally, where there are a few stiff bristles on the postero-ventral half, otherwise bare; femur (5 : 3), much swollen dorsally, practically bare; tibia (2 : 1) swollen, triangular, broad apically, with three stout external teeth placed longitudinally at the apex; the sub-apical spur strong, much curved, distinctly bifid; a few scattered short bristles on both aspects, and rows (of about six each) both dorsal and ventral, two or three bristles behind the spur being stronger. Mid legs normal; first tibial spur distinctly subapical. Hind legs (fig. 4) similar to the fore legs, the coxae being of the same length but stouter (4 : 3);

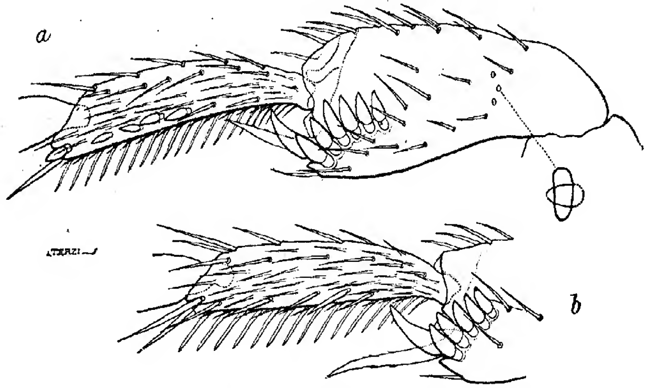

Fig. 4. Hind femur and tibia of (*a*) *Sycophaga sycomori*, L., ♀; (*b*) *S. cyclostigma*, sp. n., ♀.

the femur shorter (5 : 4) than the fore femur, but stouter; the tibia and tarsus much more developed. The antero-apical comb contains four or five teeth, and the anterior spur is also tooth-like, the posterior being a stout, sharp spine. At about one-third from the base are the three (sensory ?) structures figured; the upper surface of the chitin appears to be ovally excavated, and there is a similar, more truncate hollow on the internal surface, set at right angles to the first.

Abdomen with the caudal stigmata small and circular, separated by about seven times their own diameter.

Length (excluding ovipositor), about 2 mm.; alar expanse, over 3½ mm.

Southern Rhodesia: Salisbury, 24.xii.13, in wild figs. (*R. W. Jack*).

Holotype ♀ in the British Museum.

In the genotype *S. sycomori*, L., the caudal stigmata are very large, oval, a little narrowed anteriorly and separated by about 1½ diameters. I have examined *S. sycomori* from various localities from Greece to Egypt. *S. cyclostigma* is possibly

a southern form of it, but certainly deserves a separate name. Some interesting differences in the hind legs are illustrated in fig. 4. The short heavy spine at the apex of the tibia is constant for *sycomori*, but the similar spines along the ventral edge are less constant. In *cyclostigma* there are no peg-like spines anywhere on the tibia.

Colpixys, gen. nov. (Entedoninae).

♀. Head with distinct occipital edge; eyes hairy. Antenna cylindrical, narrow; scape, pedicel, triple ring joint; funicle three joints, the first very long; club two-jointed. Pronotum with lateral thickening at the spiracle, which is half surrounded by a smooth rim, prosternum much produced anteriorly; mesonotum flat, with four bristles on the mid lobe; propodeon with three sulci, one median and one round each spiracle. Fore wings: submarginal with two bristles, an isolated row of isoclinal bristles parallel to the hind margin. Abdomen depressed, elongated.

Colpixys necator, sp. nov.

Scape, except narrowly at apex, and ring joints clear and pale; pedicel, funicle, and club blackish brown. Head, thorax, coxae, and abdomen rich dark blue-black, dulled, except on propodeon and abdomen, by the deep sculpturing of the integument. Near the base of the abdomen and on the propodeon the coloration is metallic, and dark green overlies the blue in some lights. The blue of the coxae is also partially metallic. Veins pale, a little infuscated, tegulae darker. Hind legs from trochanter onwards entirely pale. Mid legs pale with a dark apical ventral streak on the femur reaching back over one-third; tibia with trace of a superior brown streak basally; tarsus a little darker than that of hind leg. Fore femur brownish above, paler beneath, tibia (superiorly) and tarsus smooth, the former pale beneath; claws dark brown.

Head very broad, wider than deep (9 : 7); eyes far apart, the interval varying from 3 (at the level of the anterior ocellus) to $3\frac{1}{2}$ (at the base line of the eyes) times an eye diameter; the eyes two-thirds of the depth of the head; distance between posterior ocelli to that of either from the orbit in the ratio 5 : 3. Anterior ocellus large, rounded, quadrate; toruli just above the base line of the eyes, oval, nearly circular; mouth-edge somewhat above the projecting genal angles, practically straight. Sculpture on frons, vertex and occiput coarse, regular, raised reticulate, finer towards the clypeus and for a short distance outside the genal keel; the latter distinct. Clypeal edge narrowly smooth; many fine bristles on genae and occiput, some of the latter appearing over the well-defined occipital ridge, in front of which there is one strong bristle at each side between the posterior ocelli and the eyes. Three bristles within the ocellar triangle; another pair towards the sides (1 : 1) above the level of the anterior ocellus, below which there is one bristle, inwardly directed, on each side half-way between the mid line and the orbit. About twelve bristles on each orbit, and two well above the clypeal edge in the middle; two smaller project from below. There are, besides, numerous bristles bordering the orbits (each of them rising at the corner of a raised cell), but not very regularly disposed; about sixty in all (30, 30). The eyes are clothed with a moderately long, fine pubescence; they hardly appear, in side view, above the level of the vertex. Face with practically neither post-scapal hollow, nor trace of suture.

Antennae: length, 1·25 mm. Scape narrow (4 : 1), with subparallel sides on basal half, and widest at about three-quarters, with a row of six to eight moderately long bristles on the mid line externally, and a few above and on the dorsal edge; subapical median bristle rather longer than greatest width of the joint; on the inner aspect, three or four short bristles in subdorsal row, and six or seven longish bristles all fringing the ventral edge and ventral or subventral in position; subapical bristles, as on outer aspect, if anything stouter. Pedicel (3 : 1) narrow at the base, distal edge sloped up, not transverse. First ring joint cup-shaped, large, its lower edge hardly longer than the upper; second narrow, wedge-shaped, but as broad as the first; third narrower, wedge-shaped, with a broad basal edge, fitting into the first funicular, which is much cut away posteroventrally. Funicle: first joint very long, six-sevenths of the scape; the three joints in the proportion 19 : 15 : 12, and club 9 : 9 (of which the spur is 2); in the same ratio the width varies from 4 (first funicular) to about 5 (first segment of club). Pedicel and funicle thickly set with stout bristles; the short stout capitate or mushroom-shaped spines at the apex of the funicular joints strongly developed. Sensoria (short, with free flanges, as long as or exceeding their base): on the first joint of funicle, 11; on second, 9–10; on third and first of club, 13. The second club segment bears four sensoria externally, while on the inside there are about five rows of strong sensory bristles (twenty-four in all) rising from clear pustules.

Mouth-parts: The mandibles though of the usual bidentate pattern, are peculiar: on the outer aspect are two basal swellings (the smaller more ventral), from which the surface slopes abruptly to the lower edge and the teeth; the lower tooth large, acute, with straight edges; the upper (inner) has the sides swollen basally, and the upper swelling might almost be described as a third rounded tooth, whose edge is minutely denticulate or undulate; three stout external bristles in a transverse median row, while a fourth stands subventrally at one-half, on the inner aspect. Stipes, outer lobe of first maxilla and labium all elongate; the labium, in particular, narrow, wedge-shaped (5 : 2); maxillary palpus twice as long as labial, with two stout hyaline spines, one apical and the other beyond two-thirds from the base; labial palpus likewise with two spines, apical and subapical in position. The lateral bristle of the stipes, at one half, is longer than the palpus itself; the median bristle on the labium is almost on the base line of the palpi, and of the same length; there are two short apical hyaline spines on the outer lobe of the maxilla, and numerous bristles on the inner. Lingua short and broad, with four cells.

Thorax flat; mid lobe and scutellum on same plane. Sculpture uniformly coarsely raised-reticulate, except along the posterior half of the parapsidal furrows (narrowly), the mid line of the pronotum (rather broadly), and in front of the prothoracic spiracle, where the pattern is finer. The mid lobe extends slightly beyond the downwardly inturned side-lobes, so that there is a distinct lateral gap between pro- and meso-nota. Pronotum collar-like, porrect; spiracle in a postero-lateral thickened prominence, behind and below which is a smooth rim sweeping downwards and anteriorly, so that the prominence is more than half encircled. Flaps of the pronotum long, with very oblique posterior edges; medianly the posterior edge is bare; four long bristles (2 : 2) nearer the sides and one at each spiracle. Prosternum pentagonal, truncate posteriorly, elongate in front, bare, with coarse pattern like the episternites. Mid lobe with four bristles (2 : 2); the anterior pair more approximated at about three-quarters from the suture; the second pair near the suture,

and practically standing on the parapsidal furrows, here indistinct through the development of small cells. Side lobes with two or three bristles; axillae, one bristle; scutellum with the usual two strong posterior bristles, and two small pustules (on the side sutures) which are probably setigerous and not sensory. Femoral furrows well defined. Pleurae and sternum with coarse pattern. Prepectora very large and laterally broad, but not meeting medianly, the interspace filled by a quadrate smooth sclerite. Like the mesonotum, the metanotum and propodeon are flat; the median surface of the latter and the post-scutellum parallel, nearly in the same plane; side-pieces of metanotum comparatively smooth; post-scutellum rough, with two anterior and one posterior dimple, medianly raised, but not carinate. Propodeon (fig. 5) with a deep, median sulcus whose sides diverge posteriorly; the bottom of the sulcus coarsely raised reticulate (1–2 rows of cells); outside the sulcus

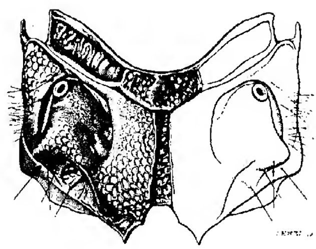

Fig. 5. Metanotum and propodeon of *Colpixys necator*, sp. n.

the notum is reticulate, the rough areas medianly contracted before a smooth depression (deep and steep-walled anteriorly), which contracts towards the oval-rimmed spiracle into a sulcus encircling the spiracle, flattening out again above the pleura and below a strong raised prominence on the posterior edge, a little beyond the level of the spiracle. Pleurae reticulate, postero-laterally nearly rectangular; posterior edge sloping towards the petiole. There are numerous bristles on the pleurae and 4–5 behind the posterior prominence.

Wings: Fore wings two and a third times as long as broad; length, 2·1 mm.; breadth, ·9 mm. Marginal; submarginal, as 5 : 4 (reckoning from the first long fringing bristle) or 3 : 2 (from the first non-setigerous pustule of the former vein). The radius and postmarginal subequal, and in the same scale, less than 1. Submarginal with two bristles; marginal and post-marginal combined with a fringe of twenty-four bristles; radius with five bristles, and three more at the edge; no clear space round the radius. The submarginal cell bears below about six bristles on the basal half, and of the row fringing the inside of the marginal on the lower surface, the first (proximal) twelve are long and conspicuous. Discal ciliation regular, sparser proximally, coming close to the marginal to within one-third from the origin of the latter. Below this point, half-way to the posterior edge, begins a row of isoclinal bristles with a clear border in front, which extends nearly to the posterior angle; there are also a few bristles between this angle and the base. Hind wings about four times as long as broad; length, 1·6 mm.; breadth, ·42 mm.; subcostal cell extremely narrow on the middle third, and filled by the vein both proximally and

distally. Basal portion of vein bare save for two minute bristles; open area bare. About twenty-five short bristles on the distal third, where the vein bears two non-setigerous pustules. Frenulum consisting of a stout spine and two hooks, with nine or ten minute bristles behind.

Legs rather long; all the coxae (particularly the hind pair) extremely coarsely raised-reticulate, surfaces of femora and tibiae reticulate with long cells; apical spurs of all the tibiae short. Fore legs: coxae elongate (2 : 1) about seven-tenths of the femur in length; pattern of femora posteriorly coarse. Tibial comb reduced to four separate spines, no specialised comb on first tarsal joint. In the hind femur there are subdorsal and ventral rows of 9–10 bristles, but the surface is otherwise bare, while posteriorly there is in addition a submedian row of eight bristles; 15–16 strong spinose bristles in the comb.

Proportions of tarsal joints (excluding claws):—

	i.	ii.	iii.	iv.
Front	35	40	37	60
Mid.	65	55	40	60
Hind	55	60	45	65

Abdomen elongate, flat, hardly carinate below; posterior edges of tergites 1–4 medianly convex; of 5 concave. Tergite 6 much the longest; 2–4 subequal; 1 longer; 7 very minute.

Length, nearly $3\frac{3}{4}$ mm.; alar expanse about $5\frac{1}{2}$ mm.

Holotype—♀ in the British Museum.

RHODESIA: Salisbury (*R. W. Jack*).

One of a pair bred from an Erotylid beetle (*Barbaropus paradoxus*, Olliff); emerged 22.xi.15.

A NEW PARASITE BRED FROM GLOSSINA MORSITANS IN NYASALAND.

By R. E. Turner and James Waterston.

Family Bethylidae.

Prolaelius glossinae, sp. nov.

♀. Nigra; scapo apice, flagello articulo primo, tibiis tarsisque anticis brunneo-testaceis; alis medio late leviterque infuscatis; basi et marginibus hyalinis.

Head as long as the greatest breadth, narrowed both in front of and behind the eyes; opaque, very finely and shallowly reticulate, with sparse piliferous punctures. Eyes separated across the frons by twice the diameter of either and situated nearer to the base of the mandibles than to the posterior margin of the head; ovate and smooth;

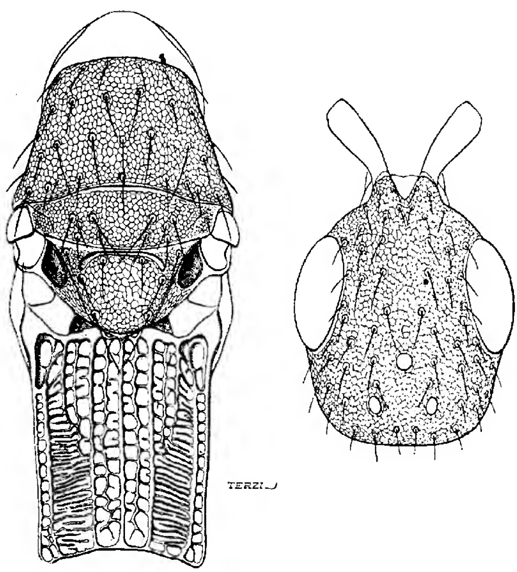

Fig. 1. Thorax and head of *Prolaelius glossinae*, sp. n., ♀.

ocelli in an equilateral triangle, the posterior pair a little farther from each other than from the hind margin of the head. *Antennae* thirteen-jointed, as long as the thorax and propodeon together. Scape about twice the pedicel, the latter slightly exceeding the first funicular joint; joints of the funicle subequal, no definite club; the last joint and the fourth and fifth of the funicle longer, equalling the pedicel.

Thorax very finely and shallowly reticulate, with sparse piliferous punctures; pronotum much broader than long, moderately narrowed anteriorly, almost as long as the mesonotum and scutellum combined. Mesonotum without parapsidal furrows;

scutellum distinctly longer than the mesonotum, rounded at the apex, with a deep depression on each side at the base, a transverse furrow at the base not reaching to the depressions. *Propodeon* as broad at the base as long, a little narrower at the apex; with three distinct longitudinal carinae in the middle; the space between them and also the space at the base on each side coarsely raised-reticulate; the lateral margins of the segment carinate, the space on the apical half between the lateral margins and the median carinae irregularly striate; the propodeon abruptly truncate posteriorly, but without a carina on the hind margin.

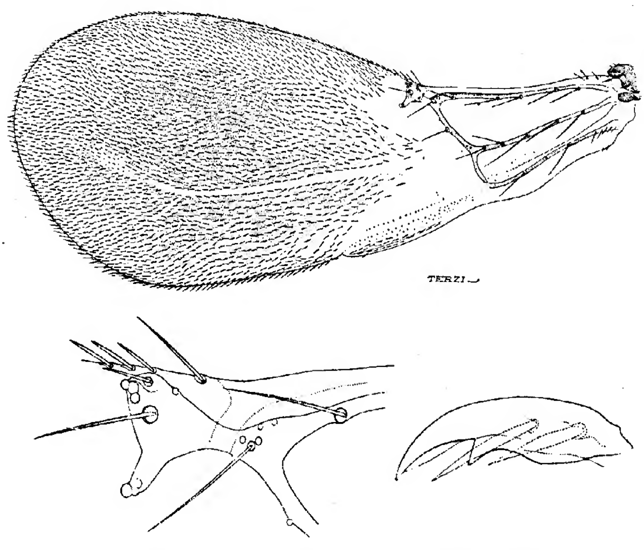

Fig. 2. Fore wing, radius and tarsal claw of *Prolaelius glossinae*, sp. n.

Wings: Fore wings not quite three times as long as broad; length, 1·7 mm.; breadth, ·6 mm.; clothed with minute hairs; with two closed basal cells; marginal vein distally broadened and infuscated towards the costa; the radius reduced to a rather short stump; the nervures with a few long bristles. Hind wings over three times as long as broad; length, 1·4 mm.; breadth, ·4 mm.

Legs: Tarsal ungues minute; about two-fifths of the fifth tarsal joint in length, with a single tooth beyond one-half, which is more distinctly developed on the outer surface, while on the inner are placed two spinose bristles.

Abdomen convex, smooth and shining; the first two tergites occupying half the visible length, quite smooth; tergites 3–5 faintly reticulate on their basal half but so slightly that the reflections are hardly interfered with.

Length nearly 3 mm. ; alar expanse, 4 mm.

NYASALAND : Monkey Bay, Lake Nyasa, x. 1915 (*Dr. W. A. Lamborn*).

Bred from pupa of *Glossina morsitans.*

Type—♀ in the British Museum.

Prolaelius glossinae appears to be nearest to *Paralaelius firmipennis*, Cameron (1905), rom Dunbrody, Cape Colony. From Cameron's description it is probable that '*firmipennis*" is a misprint for "*fumipennis*." We have placed this interesting arasite provisionally in the genus *Prolaelius*, Kieff. (Nov. 1905), which does not liffer very markedly from *Laelius*, Ashm. (1893). *Prolaelius* is merely, indeed, a ew name for the monotypic *Paralaelius*, Cam. (*nec* Kieff.), published April 1905, nd it is unlikely that Kieffer has seen any example of Cameron's species. *Paralaelius*, Kieff. (Jan. 1905) is confined to North America.

NOTES ON COCCID-INFESTING CHALCIDOIDEA—I.

By James Waterston, B.D., B.Sc.,
Imperial Bureau of Entomology.

Amongst some insects bred this year from *Lecanium viride* on coffee in Mauritius, and forwarded to the Imperial Bureau of Entomology for identification by M. d'Emmerez de Charmoy, were two species of Chalcids belonging to the genera *Diversinervus*, Silv. (1915) and *Tetrastichus*, Hal. (1843) respectively. The former, which appears to differ considerably from the genotype, is here described as a new species; the latter so closely agrees with *Tetrastichus sicarius*, Silv., that I have not thought it advisable to propose a new name. My best thanks are due to Professor Silvestri for his kindness in examining preparations of both species.

Diversinervus silvestrii, sp. nov.

A clear yellowish or honey-coloured species. The antennae and legs colourless in the main, except for a faint browning of the last joint of the club, the dorsal edge of the pedicel, narrowly on the dorsal edge and more broadly ventrally on the scape. The whole head, the apical half of the mandibles and the stipes brownish, a very faint brown spot near the apex of the mid femur on the underside and another corresponding to it on the same aspect of the tibiae near the base. Knees of the mid legs narrowly tinged with brown. On the hind legs is a moderately broad superior dark streak on the femur, and the tibia is brown apically and dorsally but without colour ventrally from before the apex to the base. Wings with the veins yellowish; the membrane tinted, obscurely clouded medianly, the basal triangle, an indefinite posterior spot at about two-thirds from the base along the hind margin, and round the apical margin more hyaline. The following regions of the thorax and abdomen are darker:—the posterior third of the mesonotum, the scutellum along the sides and towards the apex, the meso-pleurae posteriorly, the sides of the propodeon, the first tergite in front, and round about the stylets and the apex of the abdomen. The dark regions on the head and abdomen have in life a cupreous or violaceous metallic lustre.

Head in profile triangular, from the vertical aspect widely parabolic anteriorly, with a slightly concave ridged occipital edge (length to breadth about 9 : 14), a little wider than the thorax, distinctly wider than the abdomen and half as long as the latter together with the projecting part of the ovipositor, and as long as the sum of the scutellum, metanotum and propodeon. Along each orbit (from occiput to gena) are placed about eighteen short recurved bristles. Between the orbits (which diverge anteriorly) and dividing the area into three approximately equal strips are two rows of bristles (6–7 : 6–7). Lateral ocelli touching the orbits, the anterior ocellus being at the apex of an obtuse-angled triangle whose median is about one-sixth of the length of the head. Behind each posterior ocellus is a long stout bristle and between this pair and the occipital edge are four bristles (2 : 2) and about the same number in each angle formed by the edge and the orbit. Occiput distinctly concave. Frontal

aspect remarkably bare; no scapal groove; toruli widely apart, nearer to the inferiorly divergent orbits than to one another and just crossing the base line of the eyes, with 4–5 bristles between and one or two (irregular) above. Clypeus gently and broadly convex in the middle, with two clear pustules and a short slight flat lobe at each side.

Antennae: scape, pedicel, ring-joint, 6 funicular joints and 3 in club; length ·47 mm., scape (20 : 7) over twice (12 : 5) the length of the pedicel (2 : 1), just shorter than the sum of the pedicel, ring-joint and first four funicular joints, or just longer than the entire funicle excluding the club; the latter five-sixths of the scape in length and a quarter broader. The funicle joints subequal (9, 8, 8, 7, 8, 10), the first joint as broad as long, all the others transverse, 2–4 just broader than long, 5 and 6 considerably expanded, 6 being half as broad again as long. Club distinctly swollen, twice as long as broad and 2½ times as broad as the first funicular. The antenna has few sensoria, on the club 4–5, long and narrow, and apparently none on the funicle.

Mouth-parts: mandibles rather elongate, half as long again as the breadth at the base or three times that of the apex. The latter truncate, with three small teeth, the middle one broadest, the first smallest. The apical edge of the third (uppermost) tooth if produced touches the angle between the first and the second. Mainly on external apical third and above the ventral edge are about fifteen setigerous pustules. Stipes of first maxilla as long as the sum of the third and fourth joints of its palpus. The lateral bristle nearly half as long again as the first joint of the palpus. In the latter the joints are in ratio 9 : 9 : 8 : 14, and their breadths 4 : 5 : 6 : 6. The first and third are triangular, the second and fourth oblong, the latter with five bristles, three at the truncate apex, one of them twice the length of the joint itself, and one at each side. The galea bears 7–8 short apical bristles. The mid joint of the labial palpus is reduced to a narrow wedge and the joints are approximately 10 : 3 : 5, with a median breadth of 7. The longest apical bristle is nearly three times the joint.

Thorax: The general shape of the thorax and the chaetotaxy and sculpture of the mesonotum are seen in fig. 1. Pronotum in one piece, posterior edge evenly convex, not emarginate at the spiracle, two posterior rows of short bristles (8–10) and one or two single ones in front. Anteriorly the pronotum is semicircularly emarginate in the middle and just above this is a small chitinous knob raised a little from the general surface. The reticulation is transversely drawn out and much weaker on the upper portion of the overlap. Prosternum (4 : 5) with large scaly reticulation. The strong spine-like bristles on the mesonotum stand nearly erect, on the mid lobe there is a single row, on the scutellum two rows. In the figure these bristles have on one side been drawn flattened out to show their length. In conjunction with the peculiar furrowing of the notal surface, they possibly afford a hold to the male during pairing and the grooves may be comparable to similar structures in *Dytiscus* (Coleoptera). These grooves are derived from a much drawn out and raised reticulation of the mesonotum. Before the suture, about half the surface is so sculptured, the furrows being longitudinal; on the axillae and for a short space before the suture, the ridges are transverse. Near the posterior edge of the tegula, where it is in line with the suture, the surface is also grooved. The metanotum consists of two nearly separate, narrow grooved sclerites. Prepectus large, sterno-pleural surface nearly smooth, pattern faint and fine posteriorly. Upper margin of mesopleura in profile straight, without any

notch behind the middle. Propodeon on each side with a narrow striate triangular area in front of the spiracle in a plane parallel to the mid line of the scutellum. For the greater part the propodeon descends steeply and, seen from behind, is a smooth oblong (5 : 2), with the spiracle at the anterior lateral angle and a large median peduncular emargination (fig. 1, *a*).

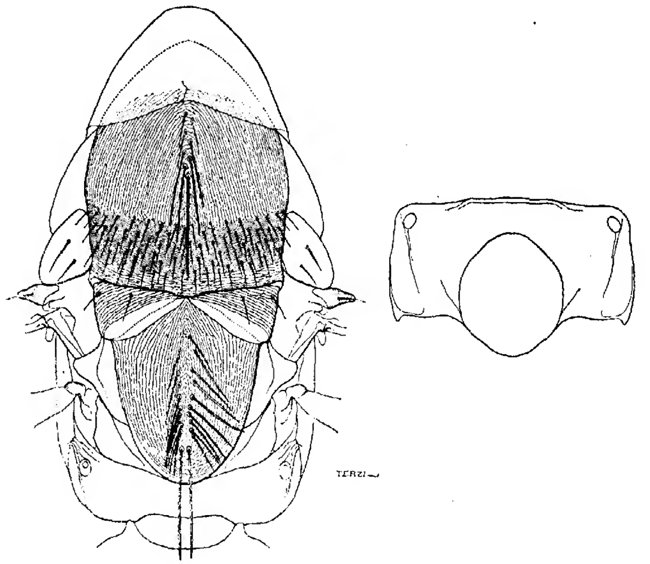

Fig. 1. Thorax of *Diversinervus silvestrii*, sp. n., ♀; *a*, propodeon from behind.

Wings: Fore wing (fig. 2) over three times as long as broad; length, ·8 mm.; breadth, ·25 mm. To give the proper effect the discal ciliation of the under as well as the upper surface for the distal two-thirds is shown. On the veins however only the bristles of the upper surface have been drawn except at the base of the radius where a conspicuous small black bristle (rising from below) is figured. The radius itself is bare, except for two subapical bristles, one at each side exactly on the edge. The hind wings are narrow, 3½ times as long as broad; length (including cilia) ·7 mm.; breadth, ·2 mm. The faint embrowning extends from the end of the nervure over the apical third.

Legs: Fore legs, femur (4 : 1) anteriorly with a sub-dorsal row of 9–11 very short bristles, 3–4 longer median and 3–4 ventral on basal half. Posteriorly, two sub-ventral longer bristles on apical third and 4–5 more medianly. Tibia (7 : 2) short, about three-fourths of the femur, spur long and distinctly preapical. Between it and the insertion of the tarsus the comb contains five spines. First tarsal joint broad, with comb of 9 closely set spines. The first and the last joint are equal, and 2–4 are equal and half as long as 1. Mid legs elongate, slender, with femur normal, antero-posteriorly compressed. Coxae (3 : 2) with vertical row of 5–6 bristles, femur (13 : 2)

narrow, band-like, broadest subapically and nearly bare, there being a few bristles dorsally on both sides towards the apex. Of these 5–6, longer, run in a slanting row from beyond half on the dorsal edge to the lower apical angle on the anterior aspect. Tibia with an apical comb of 5–6 peg-like spines, spur just shorter than first tarsal joint. Tarsal joints (in ratio 26 : 17 : 12 : 12 : 23) with the following heavy spines respectively on the anterior edge :—6, 2, 2, 1, 0. Hind legs with the coxa very broad (8 : 9) and flat, with two long bristles above the trochanter and 4–5 in front; femur (19 : 5) shorter than tibia, with a row of 6–8 ventral and subventral bristles. Tibia (11 : 2) : the upper apical angle bevelled off and the comb (10–11 spines) continued round it on the posterior edge. Anteriorly there are two spurs, both short, and the upper one about half the lower or one-third of the width of the tibia. Tarsal proportions nearly as in mid-leg, the first and second joints shorter (24 : 16).

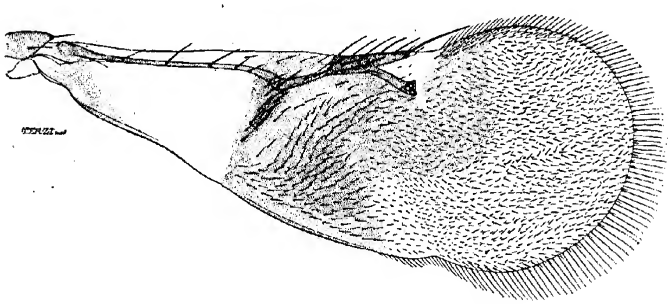

Fig. 2. Fore wing of *Diversinervus silvestrii*, ♀.

Abdomen shorter than thorax and about twice the head in length ; spiracle minute, circular. The tergites (2–6) bear at the sides (2–3, 2–3) widely separated bristles. Along the sides of the abdomen is a row of single bristles, two at most on each overlap (fused pleurite). Free portion of sheath ¼ of the base.

Length, 1·1–1·2 mm. ; alar expanse about 2 mm.

In *D. silvestrii*, sp. n., the club is broader and as long as the 5 preceding funicular joints and half of the sixth together. In *D. elegans* the club is narrower and as long as the 4 preceding joints and half of the fifth. In *silvestrii* only the first normal funicular joint is longer than wide, the rest being transverse, while in *elegans* the first 3 joints are cylindrical. In *silvestrii* the thorax as a whole is much longer than the abdomen, whilst in *elegans* the two are equal. In the fore wings of *silvestrii* the fringe is long ; there are 4 bristles below the submarginal distally, and the marginal plus the post-marginal bears 4–5 bristles besides the long apical one. In *elegans* the fringe is short, 22 bristles below the sub-marginal vein and 8 bristles, plus an apical stronger one, along the margin. In the mid-legs of *silvestrii* the tibia has an apical comb of 6 spines ; on the first tarsal joint are 3 pairs of short thick plantar spines, whilst at the apices of joints 2–4 are 1–2 similar spines. In *elegans* the tibial comb consists of 10 peg-like spines ; there are 8 pairs on the first tarsal joint and 4–5 spines on joints 2–4 apically.

Tetrastichus sicarius, Silv. (1915).

T. sicarius, Silvestri, Boll. Lab. Zool. R. Sc. Agr. Portici, IX (20th Feb. 1915), p. 325, figs. lxxiv–lxxv.

A short series, females only. Professor Silvestri, whose type was bred from *Chionaspis olivina*, Leonardi, from Nefasit, Eritraea, writes that in these Mauritius examples the funicle is a little longer than in his own specimens.

Coccophagus acanthosceles, sp. nov. (fig. 3).

An entirely blackish brown species, only the tarsi and the base of the abdomen obscurely paler.

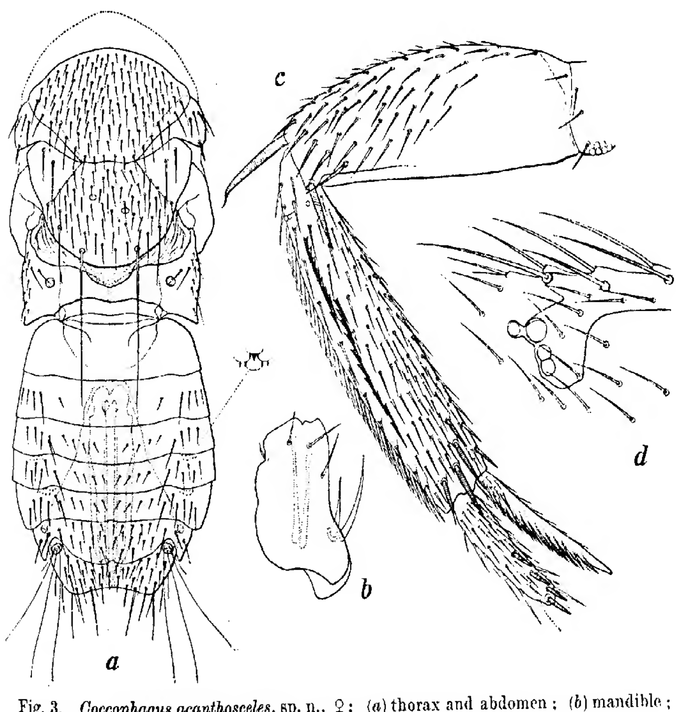

Fig. 3. *Coccophagus acanthosceles*, sp. n., ♀; (*a*) thorax and abdomen: (*b*) mandible; (*c*) mid-leg: femur, tibia, and first tarsal joint (anterior aspect): (*d*) radius.

♀. *Head* wider than deep (6 : 5). Eyes large, occupying three-fifths of the depth of the head and separated at the mid frons by exactly the diameter of either; closely set with small bristles, one of which rises at every alternate angle of the very regular hexagonal facets; the lower orbits are more divergent, and the lower angles of the eyes are one and four-fifths diameters apart. Below the anterior ocellus there is a narrow groove to shortly before one-half, where it meets the convergent post-scapal grooves of the upper portion of the scrobes, which form an inverted V; the sockets

themselves are oblong, quadrangular and narrowed slightly above. The antennae are set slightly above half-way between the base line of the eyes and the mouth-edge; the latter nearly straight, not re-entrant, with two slight obtuse prominences at the sides of the clypeus; genal keel obsolete, at most a trace at the lower corner of the eye. Reticulation of face fine, faint above the middle; below more definitely raised and drawn out parallel to the orbits and scapal hollows; between the scrobes more regular; on the bare occiput the pattern is larger and raised. Face very hirsute, over 100 short bristles on each side of the mid line between the anterior ocellus and mouth-edge, about a dozen between the scrobes, and over 20 on the clypeus.

Antennae: length ·38, scape (nearly 3 : 1) as broad as the pedicel and nearly twice as long, but just shorter than (*a*) the club, or (*b*) the sum of the funicular joints, or (*c*) the pedicel and the first two of the funicle together; pedicel (10 : 7) longer than the first funicular joint, and half as long as the club; ring joint single, very minute; normal joints of funicle subequal (16 : 16 : 15), with a uniform breadth of 15; club swollen, in three subequal segments (14 : 12 : 13) with a maximum breadth of 20.

Mouth-parts: Mandibles shortly cut back rectangularly, both dorsally (more deeply) and ventrally, having a broad thin sharp straight-edged chisel-like apex; outer surface with three bristles behind the apex, and two stout spines, one ventral and basal in position, the other shorter, above, on the inner surface, where there are also two or three minute bristles, subapical and dorsal. The two internal ribs are long, equal, and gradually tapered. First maxilla with three short lateral stipes, and 3-4 other bristles; pattern large, a little raised; first joint of palpus bare, three-fifths of the second, which bears two bristles—one median and one pre-apical, besides a terminal slender spine nearly as long as the joint itself. The galea bears two to three short marginal bristles; second maxilla, labium a perfect oblong (10 : 7), palpus slightly exceeding (7 : 6) the basal joint of the maxillary palpus, with one median and a longer terminal bristle as long as the joint itself.

Thorax: all the bristles stiff and spine-like. Pronotum with a strong bristle above the nearly semicircular spiracular emargination, a posterior row of about 24 between and many others, more minute, in front. Mid-lobe: along each parapsidal furrow are 6–7 longer bristles and 4 others in front of the suture; besides these there are about 120 short bristles distributed evenly over the lobe, arranged in rows, but not distinctly in bilateral symmetry about the mid line. Side lobes: four bristles outside the furrows and one before the tegulae; axillae with two bristles; scutellum: situated on the posterior edge, which they divide into three approximately equal sectors, are two stout bristles one and a half times as long as the scutellum itself. In front of each, rather nearer to the posterior angle of the axilla, is an additional bristle, one-third of the length of the first pair; like the mid lobe, the scutellum is evenly covered with short bristles, but only half as numerous; the density on both areas is about the same. The pattern of the thoracic notum is indistinctly fine; transversely drawn out, and more distinctly raised transversely than longitudinally; the reticulation is thus somewhat scaly. Besides this pattern the whole integument when highly magnified shows numerous very minute close-set pustules or clear punctures. Metanotum: the post-scutellum broadly convex, rather flat, posteriorly declivous, projecting over the propodeon; its surface covered with large slightly raised cells, radiating from a clear, medio-basal spot, each ray consisting of not more

than two cells. Side-pieces each with two bristles, nearly smooth towards the post-scutellum, but laterally with four long complete transverse rugae, and others shorter, incomplete, between; propodeon narrow medianly, and declivous from the mid line towards the sides, but without a keel. The slopes of the notum without pattern, but crowded with minute pustules, descending to before the spiracle, where there is a straight, longitudinal, internal, rod-like thickening of the sclerite, but no external ridge or keel; just outside this thickening, nearly at one-half, is the small spiracle, with two bristles in front, and 3–4 in a flanking, longitudinal row, with 1–2 more below. The whole surface of this area is reticulate, hardly raised. Sternopleurae: presternite six-sided, very short and broad, with strong transverse pattern, bare; episternite helmet-shaped, with pattern of sternite; two minute bristles. The prepectora are broadly fused with a band which is not much wider laterally than on the smooth mid area. The pattern is large and coarse, 3–4 cells occupying the length and 10–12 the depth of the sclerite. The mesopleurae are very finely striate on their entire length—the striae (about 40 deep) consisting of long drawn-out cells.

Wings: Fore wings: two and one-third times as long as broad; length, ·6 mm.; breadth, ·26 mm.; marginal nearly twice as long as the submarginal. The latter bears six single bristles, with an additional pair before the clear pustules; the marginal is fringed by 14 bristles, and there are 12 equally strong on the vein parallel with the long axis of the latter, which bears besides numerous minute bristles; two bristles and four cells on the drop-like radius. Hind wings over three times as long as broad; length, ·5 mm.; breadth, ·15 mm.; about 20 fine short bristles along the marginal.

Legs: Fore-legs: coxae two-thirds as long as the femur, with coarse pattern on outer surface, three stong bristles on the ventral two-fifths in a perpendicular row and about a dozen minute ones at the same level behind; Femur (5 : 2) half as long again as the tibia, which folds up for its whole length against a deep, bare apical-ventral excavation in the former; anteriorly a few short bristles on the basal third, while above the groove the subdorsal surface is covered with bristles; posteriorly, two weak subapical median bristles and another stout subapical and ventral, with an irregular ventral or subventral row (8–9) reaching to the base; apical comb feebly developed, three bristles near the long broadly-curved spur whose apex crosses the tarsus at the ventral angle of the first joint; the latter with a comb of nine thin unequal spines, the lowermost being shorter. Midlegs: coxae (1 : 1) one-half the length of the femur, with coarser pattern than the fore coxae and similar chaetotaxy, bearing four stout bristles and about forty smaller; femur (3 : 1) with distinct pattern on both sides, the cells posteriorly subequal and large, anteriorly on the basal half and ventrally to near the apex they are long drawn out and the surface is bare; the distal half to below the mid line bears about 40 bristles, 3–4 at the apex stronger while there are 2 stout apical spines, the upper bent at the tip; tibiae (4 : 1) with four spines near the apex, the anterior surface covered thickly with small bristles; the entire dorsal edge with a close set row of short spine-like bristles, of which a second row, subdorsal, runs from the base to near the apex; the thickly feathered spur is one-third longer than the first tarsal joint. Hind legs: coxae (3 : 2) very large, broad and compressed, practically as long as the femur and nearly bare, there being only a few short bristles at the ventral angle; femur (2 : 1) similar to the mid femur,

with anteriorly a ventral row of about 12 short bristles, but with fewer bristles on the apical third—about 15 in all; tibiae (10 : 3) with two short subapical median spines, and one rather longer smooth apical dorsal spine, the closely appressed short spines covering more than one-third of the anterior subdorsal surface, and there being besides a subventral row of the same spines; two apical ventral spines about four-fifths as long as the first tarsal joint; the tibial comb consisting of 14 short hyaline spines.

Proportions of the tarsal joints :—

	i.	ii.	iii.	iv.	v.
Front	16	7	6	5	12
Mid	30	18	12	10	12
Hind	24	14	12	10	16

Abdomen: First tergite longest, and 1–3 subequal; 4 and 5 shorter; 6 postero-medianly a little incised, with minute spiracle. Tergites 3–5 bear complete post-median rows of bristles; the sixth has three rows and the seventh four, there being about 40 bristles on the dorsal surface (excluding the overlapping portions behind the stylets, from which rise three long and one short bristles), of which 4, on the posterior edge in widely separated pairs (2 : 2), are longer. Especially on the basal tergites the pattern is faint, but stronger and scale-like posteriorly; the posterior sternites bear medianly many bristles.

Length, just over 1 mm.; alar expanse, 1·55 mm.

Type—a ♀ (on three slides) in the British Museum.

Strait Settlements: Singapore (*J. H. Burkill*).

This specimen was extracted by Mr. E. E. Green from the body of a scale-insect (*Lecanium* sp.) occurring in hollow stems of a macaranga plant and sent to him by Mr. Burkill, the Director of the Botanic Gardens, Singapore.

Amongst the black or purplish or prevailingly dark brown species of *Coccophagus*, *C. acanthosceles* differs from *purpureus*, Ashm. (1886) and *orientalis*, How. (1896) in the hyaline wings, from *funeralis*, Gir. (1913) in the coloration of the legs, and from *immaculatus*, How. (1880) in the puncturation of the scutellum. In *oleaphilus*, Silv. (1915) the scape is about three times as long as the pedicel, while the mandibles, mid tibiae and antennae separate the Singapore species at a glance from *princeps*, Silv. (1915). Dr. Masi has very kindly examined the type and reports that his *niger* (1909) belongs to a different section of the genus. In the antennal characters the new species possibly comes closest to *orientalis* and in the thorax to *princeps*, but it appears to be very distinct from anything yet described. The antennae and fore wings are short in the type; possibly in fully developed specimens they might be a little longer. The general coloration in life also is probably submetallic on the head and thorax.

TEN NEW AFRICAN HAEMATOPOTA.

By F. W. Edwards.

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(Plate II.)

A small number of *Haematopota* from the Congo were recently sent for determination to the British Museum by M. E. Roubaud of the Pasteur Institute. Among these were specimens of an interesting new species of the *H. pertinens* group, and as M. Roubaud was kind enough to say that the type of this species might be deposited in the British Museum, I undertook to describe it, including at the same time, at Dr. G. A. K. Marshall's request, descriptions of a few of the numerous unrecorded African species of this genus in the collections of the British Museum and the Imperial Bureau of Entomology. The following is a list of the ten new species described below, with the countries from which they were respectively obtained :—

**H. pulchella*,	sp. n.	.. ..	Nyasaland.
**H. fasciatapex*,	,,	.. ..	Nyasaland ; N.E. Rhodesia.
†*H. pallidicornis*,	,,	.. ..	S. Nigeria.
**H. crassicrus*,	,,	.. ..	British East Africa.
†*H. mordens*,	,,	.. ..	Gold Coast (Northern Territories).
**H. nefanda*,	,,	.. ..	Uganda.
**H. obsoleta*,	,,	.. ..	Nyasaland.
**H. rabida*,	,,	.. ..	,,
†*H. furians*,	,,	.. ..	Sierra Leone.
H. perturbans,	,,	.. ..	Congo.

The types of the species marked * have been presented to the British Museum by the Imperial Bureau of Entomology ; those marked † by the collectors.

Descriptions of the wing-markings of *Haematopota* are difficult to write and still more difficult to read, but they have been rendered entirely unnecessary by the beautiful photographs prepared by Mr. A. Cant. The outline drawings of the heads have been made by Mr. A. J. E. Terzi with his usual accuracy and skill, and it is hoped that with the aid of these figures and photographs, the short descriptions given will be sufficient to enable the species to be recognised with certainty.

Haematopota pulchella, sp. nov. (Pl. II, fig. 4).

♀. *Head* (fig. 1) : Face and jowls whitish, with long white hair ; a pair of dark brown spots adjoining each eye just below the antennae. Front rather dark brown, margins narrowly light grey, more broadly so towards the vertex. Median frontal spot absent ; lateral spots rather large, perpendicularly oval, usually bordered with light brown. Frontal callus rather broad, wrinkled, extending from eye to eye, with its upper margin gently convex ; in colour it is either entirely shining black or else

blackish above and clove-brown below. Spot below callus velvet black, almost divided into two from beneath by a grey streak. *Antennae* wholly black; first joint moderately shining, swollen, not quite three times as long as its greatest breadth. *Palpi* light grey, clothed with whitish hairs towards the base, shorter black ones on the apical two-thirds.

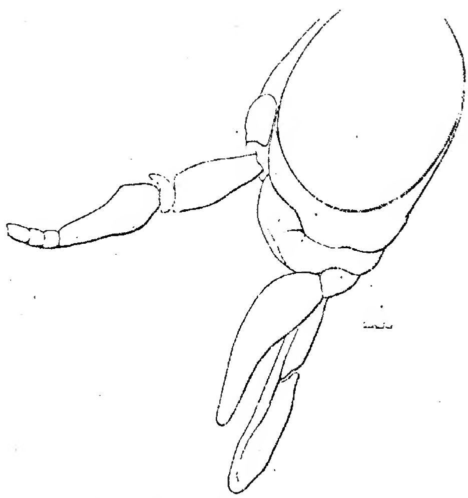


Fig. 1. *Haematopota pulchella.* Edw., sp. n.

Thorax dark, almost blackish brown above, with conspicuous pale markings, as follows: Margins of scutum as far as the wing-base greyish; a pair of rather narrow but sharply defined creamy lines extending from the front margin to the conspicuous post-sutural spots; usually a short very narrow median stripe from the front margin; a large creamy area just in front of the scutellum, almost as broad as the latter and produced forward into three points, also with a small lateral extension which is sometimes joined to a small pale spot just interior to the post-alar calli. Scutellum brownish cream-coloured, with large dark brown lateral spots. Mesonotum very sparsely clothed with short dark and yellowish hair; some black hair in front of wing base; a tuft of whitish hair on the post-alar calli. Pleurae greyish.

Abdomen blackish-brown, the first two or three segments usually more or less reddish brown, this colour sometimes extending over the greater part of the abdomen; hind margins of all the segments narrowly pale; tergites 4 to 6 or sometimes 3 to 6 with pairs of inconspicuous paler spots near the base. Whole dorsal surface of the abdomen clothed with short black hair, except on the lateral margins, where the hair is rather longer and white. Venter greyish.

Legs: Front legs black; coxae whitish on the basal half, which is clothed with long white hair; tibiae moderately thickened towards the tip, a broad white ring near the base. Middle legs black; tibiae with two conspicuous creamy rings; metatarsus pale at the base. Hind legs blackish; femora rather lighter at the base

and fringed beneath with whitish hair; tibiae with a broad whitish ring close to the base, and a much narrower and indistinct brownish ring nearer the tip; metatarsi pale on the basal two-thirds.

Wings smoky, with darker clouds over the cross-veins; on the hind margin are two conspicuous white spots in the second and fifth posterior cells. Squamae dark. Halteres entirely cream-coloured.

♂. Very similar to the female, but the hair on the first antennal joint, the pleurae, the hind femora and the under side of the abdomen is longer and denser; the tip of the abdomen is less darkened and the pale hind borders of the tergites are less noticeable.

Length (without antennae, average specimen), 12·5 mm.; wing-length, 11 mm.; width of head, 4·1 mm.; width of front at vertex, 1·2 mm.

NYASALAND: Mt. Mlanje, 30.x.–2.xii.1913, commonest at about 3,000 ft. (*S. A. Neave*).

A series of two males and about 200 females is in the possession of the Imperial Bureau of Entomology, of which the males and 17 females have been presented to the British Museum.

H. pulchella is apparently most nearly allied to *H. alluaudi*, Surc., and *H. distincta*, Ric., but may easily be distinguished by the obsolescence of the outer pale band on the hind tibiae and by the two conspicuous white spots on the hind margin of the wing. What is apparently a melanic form of *H. alluaudi* was also found commonly by Mr. Neave on Mt. Mlanje, but occurred chiefly at higher altitudes. *H. pulchella* also bears a considerable, though quite superficial, resemblance to *H. neavei*, Aust.

Haematopota fasciatapex, sp. nov. (Pl. II, fig. 6).

♀. *Head* (fig. 2): Face and jowls light grey, with whitish hair; the former with some brownish speckling on the upper part towards the eyes. Front rather light

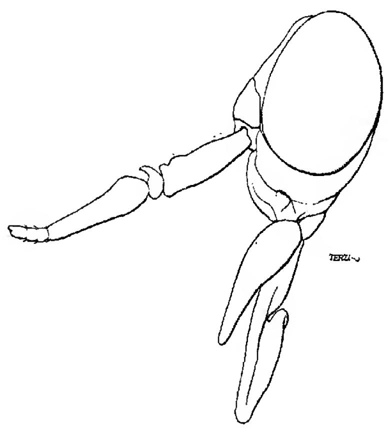


Fig. 2. *Haematopota fasciatapex*, Edw., sp. n.

greyish-brown, with short black hair; median spot small or absent; lateral spots large, round, touching the eyes, and also almost touching the upper margin of the

frontal callus; borders rather paler. Frontal callus moderately broad, shining blackish-brown or dark brown, not much wrinkled, its upper margin rather strongly convex; it touches the eyes for some distance, but separates slightly in the upper part. Spot below callus rounded, velvet-black. *Antennae* dingy reddish-brown, extreme base of third joint grey, especially on the upper surface, terminal annuli black. First joint not shining, scarcely thickened, about four times as long as its greatest breadth. *Palpi* pale greyish, clothed with black and whitish hairs, the former most numerous towards the apex.

Thorax dark brownish, more greyish towards the front, the three pale stripes only extending a short distance from the front margin and not very distinct; post-sutural spots distinct. Scutum with short black hair and pale yellowish close-lying pubescence, the latter much denser in a transverse band just in front of the scutellum, accentuating to the naked eye the conspicuousness of the grey markings in this position. Scutellum dark brownish, clothed with black hair. Pleurae light grey, with white hair.

Abdomen rather dark brown, more reddish-tinged basally; second segment paler in the middle, third to sixth with pairs of somewhat elongate pale spots; lateral and posterior margins of segments light brownish and with some pale pubescence, the pubescence elsewhere on the dorsum being black. Venter dusted with grey, yellowish basally, pubescence pale, except on the last segment where it is longer and black.

Legs: Front coxae light greyish, remainder of legs black, tibiae distinctly swollen, with a white ring at the base. Middle legs brownish, tarsi darker, except for the pale base of the metatarsus; tibiae with two distinct and equally broad whitish rings. Hind legs blackish, femora lighter towards the base, tibiae slightly thickened, with one rather broad white ring at the base, no trace of a second ring; fringe of black hair on the outer side slightly longer than usual, as long as the width of the tibia; basal half of metatarsi pale.

Wings greyish brown with white markings; no darker clouds; no conspicuous pale patch at the anal angle. Squamae coloured like the ground colour of the wings. Halteres light yellowish, base of knob somewhat darkened.

Length, 10 mm.; wing-length, 9·5 mm.; width of head, 3·2 mm.; width of front at vertex, 1·0 mm. (measurements of type).

NYASALAND: Ngara, i.1915 (*Dr. J. B. Davey*), 1 ♀ (type). N.E. RHODESIA: Luangwa Valley, Petauke, 2,400 ft., 22.i.1905, 4 ♀, and 8–9.i.1908, 2 ♀ (*S. A. Neave*).

The Rhodesian specimens are on the average rather larger than the type, and the first antennal joint is a little shorter, but there can be no doubt that they belong to the same species. They are very much rubbed and so do not show the band of pale pubescence on the thorax.

H. fasciatapex is nearly related to *H. divisapex*, Aust., and *H. insatiabilis*, Aust., but differs in the longer and more slender first antennal joint, in the absence of any trace of a second pale ring on the hind tibiae, and in the absence of a white patch at the anal angle of the wing; also in the more conspicuous pubescence of the thorax.

Haematopota pallidicornis, sp. nov. (Pl. II, fig. 10).

♀. *Head* (fig. 3): Face and jowls mostly greyish, with rather short yellowish hair; an irregular dark patch beneath the antennae, a clearly defined dark brown patch on each side of this touching the eyes, a dark transverse streak across the lower margin of the face from the eyes to the bases of the palpi; clypeal pits larger than usual and shining dark brown, instead of dull greyish like the ground-colour of the face. Front rather dark brownish, with short black hair; median spot minute; lateral spots rounded, almost touching the eyes, but some distance above the upper margin of the callus. Frontal callus shining black, smooth, very prominent, moderately deep; its sides rounded and not quite reaching the eyes even at the widest part; upper margin convex with a slight upward projection in the middle. Spot below callus rather small, velvet-black. *Antennae* almost uniformly light reddish-brown, terminal annuli more brownish; first joint dull, nearly cylindrical, about three times as long as broad. *Palpi* brownish, clothed with light and dark hair intermixed.

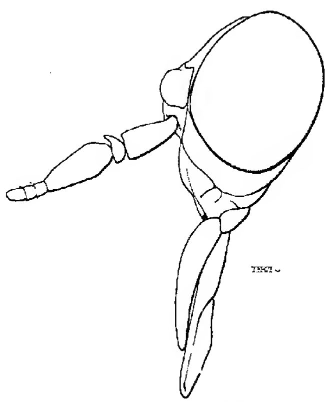


Fig. 3. *Haematopota pallidicornis*, Edw., sp. n.

Thorax dark greyish brown; pale markings very much reduced, the median stripe of the scutum being entirely absent; lateral stripes short, narrow, not distinctly reaching the post-sutural spots, which are inconspicuous; a pair of somewhat rounded grey spots in front of the scutellum; scutellum entirely light grey. Scutum and scutellum rather densely clothed with pale yellowish pubescence, except for the middle part of the former, which has short black hair instead; the yellowish pubescence appears to the naked eye to form a pair of slightly divergent pale stripes from the front margin to the post-sutural spots; it is also denser about the suture and before the scutellum. Pleurae somewhat lighter, with whitish hair.

Abdomen blackish brown above, the posterior margins of the segments conspicuously whitish; segments 4–6 with pairs of small elongate grey spots towards their bases; pubescence black, except at the posterior corners of the segments, where it is whitish. Venter blackish, with conspicuous whitish pubescence towards the apices of the segments.

Legs: Front legs blackish, coxae at the base grey, clothed with long pale hair; tibiae very little thickened, white on rather more than their basal half. Middle and hind legs blackish, tibiae each with two conspicuous whitish rings, of which the basal one is very broad, occupying nearly half the tibia, and separated from the apical one by quite a narrow dark ring; metatarsi pale towards the base, more extensively so on the middle legs; middle femora not so dark as the hind pair.

Wings dark, with well-defined cream-coloured markings; no darker clouds; stigma extensively pale at the base; an almost horizontal pale streak in the anal cell. Squamae light coloured. Halteres yellowish.

Length, 9 mm.; wing-length, 7 mm.; width of head, 2·8 mm.; width of front at vertex, 0·7 mm.

SOUTHERN NIGERIA: Cross River, i.i.1910 (*C. W. Jemmett*), 2 ♀ (incl. type); Ikotobo, xii.1913 (*Dr. J. W. Scott Macfie*), 1 ♀ (specimen figured).

Although this species has a certain amount of superficial resemblance to *H. crudelis*, Aust., and *H. cruenta*, Aust., it appears to have no near relative, unless the form of the frontal callus indicates some connection with *H. bullatifrons*, Aust. The most salient features of *H. pallidicornis* are the light-coloured antennae, the remarkable frontal callus, the very extensively pale tibiae, and the course of the pale streak in the anal cell. I retain the name which I found had been suggested for it by Mr. Austen.

Haematopota crassicrus, sp. nov. (Pl. II, fig. 1).

♀. *Head* (fig. 4): Face and jowls grey, with whitish hair; a small roundish black spot beneath each antenna; a slight dark cloud at the eye margin. Front dark grey, lighter in the middle and sides of the vertex and round the black spots. Median frontal spot very small or absent; lateral spots irregularly triangular, remote from the eye-margins. The front is clothed with short black hair towards the vertex,

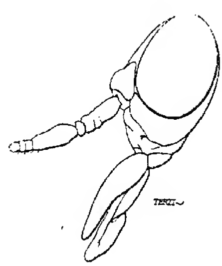


Fig. 4. *Haematopota crassicrus*, Edw., sp. n.

and with longer whitish hair below. Frontal callus shining black, moderately wrinkled, touching the eyes below, but separated above; its upper margin produced upwards laterally and in the middle, the median projection variable in height and breadth, sometimes reaching as far as the upper margin of the frontal spots. Spot below frontal callus velvety black. *Antennae* dull blackish grey, terminal annuli of third joint black. First joint nearly cylindrical, but with its outer face somewhat concave; about three times as long as broad; second joint roundish. *Palpi* rather dark grey, clothed with mixed light and dark hairs.

Thorax dark blackish grey, dorsum clothed with close-lying whitish pubescence. Scutum with rather inconspicuous grey markings arranged on the usual plan; median pale stripe running the whole length of the scutum; lateral stripes usually not reaching the post-sutural spots; pale area before scutellum consisting of four contiguous more or less triangular spots, the inner and larger pair with their apices pointing forwards in a line with the post-sutural spots. Scutellum sometimes paler in the middle, especially towards the tip. Pleurae very little lighter than the dorsum, with rather short whitish hair.

Abdomen rather short and stout, dark blackish-grey, sometimes with a brownish tinge; all the tergites with the posterior margins conspicuously light greyish, and all except the first with paired rounded brownish-grey spots. Pubescence short, mainly black, but with some pale hairs on the lateral and posterior margins of the segments. Venter coloured like the dorsum, but without rounded paired spots.

Legs: Front legs black; coxae and under side of femora more grey; tibiae with a moderately broad and rather ill-defined pale ring near the base, very much swollen a little beyond the middle, but somewhat contracted again apically. Middle and hind legs with the femora dark grey, blackish towards the tips, tibia blackish with two rather ill-defined brown rings; tarsi blackish, the basal half of the metatarsi obscurely pale. Hind tibiae rather stouter and with the pale rings less conspicuous than in the middle pair.

Wings rather dark grey, no darker clouds over cross-veins; stigma entirely dark; markings well-defined, white; the spot near the tip is broad and conspicuous. Squamae brownish, the margin darker. Halteres with pale yellowish stem, knob blackish brown with a lighter brown tip.

Length, 7 mm.; wing-length, 6·8 mm.; width of head, 2·7 mm.; width of front at vertex, ·9 mm.

British East Africa: Kuja Valley, S. Kavirondo, 4,000 ft., 30.iv.–1.v.1911 (*S. A. Neave*).

A series of 78 ♀ taken by Mr. Neave, of which 12 (including type) have been presented to the British Museum by the Imperial Bureau of Entomology.

H. crassicrus belongs to the same group as *H. vexans*, Aust., and *H. maculosifacies*, Aust. It is rather closely allied to the latter, but differs in having only two distinct black spots on the face, considerably shorter antennae, broader front, more spotted and rather broader abdomen, less distinctly ringed tibiae, and darker halteres.

Haematopota mordens, sp. nov. (Pl. II, fig. 8).

♀. *Head* (fig. 5): Face and jowls greyish, without definite markings, hair whitish. Front brownish, side margins and outlines of lateral black spots pale grey, the spots round, separated from the eye-margins. Frontal callus shining blackish, not much wrinkled, rather narrow, almost but not quite touching the eyes; its lower margin concave, its upper margin more or less straight, slightly raised in the middle. Spot below callus velvet-black. *Antennae* dark brownish; first joint dull, greyish tinged, somewhat swollen, only about twice as long as its greatest breadth. *Palpi* greyish-brown, clothed with black hair.

Thorax dark greyish-brown; markings of the usual type but indistinct; median stripe perceptible along whole length of scutum; lateral stripes reaching the inconspicuous post-sutural spots; scutellum dark; sparse yellowish pubescence on scutum.

Abdomen blackish-brown, with a slightly reddish tinge towards the base, hind margins of segments grey, with pale pubescence. Venter rather lighter in colour.

Legs: Front legs dark brown; tibiae considerably swollen, with a rather narrow and inconspicuous pale ring at the base. Middle legs: femora brown, darker at the tip; tibiae whitish, except on the apical fourth, which is dark brown; there is no trace of a dark area dividing the pale part of the tibia into two rings; metatarsus whitish with blackish tip; second to fourth tarsal joints pale at the base. Hind legs similar to the middle pair, but the tibiae have only an indistinct whitish ring at the base and faint traces of another narrower one beyond the middle. Pubescence on the mid and hind femora and tibiae mainly pale.

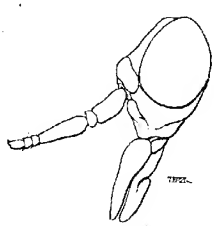


Fig. 5. *Haematopota mordens*, Edw., sp. n.

Wings dark greyish, with white markings; a conspicuous somewhat crescent-shaped white mark close to the tip. Squamae pale. Stem of halteres yellowish, knob darker.

Length, 6 mm.; wing-length, 5·5 mm.; width of head, 1·9 mm.; width of front at vertex (in type specimen), 0·75 mm.

Northern Territories, Gold Coast: Dimbipe, 19.vii.1910, 1 ♀ (type); Fadama, road to Dogankade, 6.vi.1910, 1 ♀; Salaga, biting boy near constabulary lines, 23.vi.1910, 1 ♀; Naquair, yam farms, 1–2.viii.1910, 2 ♀. All collected and presented by *Dr. F. J. A. Beringer.*

The Fadama and Salaga specimens differ from the type in having the front distinctly broader (·45 instead of ·39 of the width of the head). The Naquair specimens also have a slightly broader front than the type, and in these the middle tibiae have the usual two pale rings, being darkened at the base and just beyond the middle; the rings however are not conspicuous and the pubescence of the tibia, as in the type, is mainly pale; in addition the Naquair specimens have the pale markings along the hind border of the wing rather less developed.

H. mordens appears to be most nearly allied to *H. vexans*, Aust., from which it can be easily distinguished by the shorter first antennal joint, less swollen front tibiae, paler middle tibiae, and different wing-markings, especially towards the apex of the wing.

Haematopota nefanda, sp. nov. (Pl. II, fig. 5).

♀. *Head* (fig. 6): Jowls and lower part of face at sides rather dark grey, with pale hair, centre and upper part light brownish; no dark spots or clouds. Front rather light brown, with short black hair towards the vertex; median spot usually absent; lateral spots large, roundish, touching the eyes. Frontal callus rather broad, nearly smooth, shining blackish-brown, extending from eye to eye, its upper margin convex and rising to a point in the middle. Spot below callus velvet black. *Antennae* reddish brown, third joint blackish brown, except towards the base. First joint rather shining, considerably swollen towards the tip, nearly three times as long as its greatest breadth. *Palpi* brown, clothed with black hair.

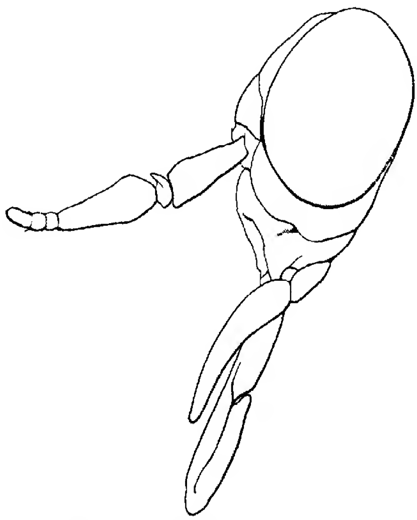


Fig. 6. *Haematopota nefanda*, Edw., sp. n.

Thorax brown, markings lighter brown; median stripe fairly distinct and running the whole length of the scutum; lateral stripes reaching the post-sutural spots, which are not very conspicuous; margins of scutum also pale; a pair of nearly semi-circular greyish spots just in front of the scutellum. Scutellum rather paler than the scutum. Mesonotum rather thickly clothed with dark hair and yellowish pubescence. Pleurae brownish grey with whitish hair.

Abdomen rusty-brown, the last three or four segments usually darker, slightly shining. Margins of tergites very narrowly and indistinctly lighter. Pubescence black, except at extreme lateral margins. Venter dark brownish grey.

Legs: Front legs black; coxae brown, clothed with long white hair on the basal half; tibiae slightly thickened, with one, not very broad, cream-coloured ring near the base. Middle legs rather dark brown; all the tarsal joints black at the tips; tibiae with two rather obscure paler rings. Hind legs dark brown; femora with

margin with a median projection on each side of which it is somewhat concave. Spot below callus velvet black. *Antennae*: First joint considerably swollen, about three times as long as its greatest breadth; outer half (from base to apex) blackish, inner half rather light brown. Second joint similarly coloured. Enlarged portion of third joint dark brown on its outer face, especially towards the base and apex, inner face entirely reddish brown; terminal annuli black. *Palpi* light brownish, with black hair, except at the extreme base.

Thorax rather dark greyish brown with inconspicuous markings consisting of three greyish lines from the front margin, of which the lateral pair are broadest in front, narrowed behind, and just reach the usual postsutural spots; a median line extending to the scutellum, but usually interrupted; and a pair of small light spots in front of the scutellum. Scutellum usually more or less reddish at the tip. Whole mesonotum rather densely clothed with close-lying yellowish pubescence, and also with sparser, more erect dark hairs. Pleurae greyish, clothed with white hair.

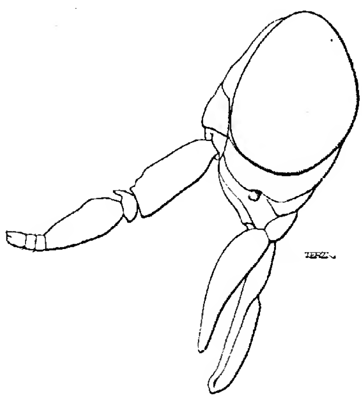


Fig. 8. *Haematopota rabida*, Edw., sp. n.

Abdomen reddish brown, the last few segments dark brown and with pairs of inconspicuous lighter spots. Hind margins of all the tergites narrowly, but quite conspicuously, light brown. Pubescence short, black, except on the lateral margins of the segments, where it is whitish. Venter greyish, darker apically.

Legs: Front coxae light brownish, tip dark; basal half with long white hair, apical half with shorter black hair. Femora rather darker brown. Tibiae moderately thickened apically, black, with a broad white ring which occupies almost the entire basal half. Tarsi black. Middle femora light brownish; tibiae darker, with two distinct equally broad pale brown rings; tarsi blackish, the basal two-thirds of the metatarsus pale. Hind femora light brownish; tibiae somewhat swollen, darker brown, with a broad whitish ring at the base and very indistinct traces of another much narrower ring towards the apex. Tarsi blackish brown; basal three-fourths of metatarsus whitish; bases of remaining joints indistinctly pale.

Wings evenly darkened; no darker clouds over the cross-veins; stigma inconspicuous. Squamae with a pale margin. Halteres either entirely yellowish or with the base of the knob slightly darkened.

♂ (if correctly associated with ♀). Antennae more slender; first joint somewhat shorter and not very much paler on the inner side than on the outer. Hair everywhere rather longer. Front and hind femora blackish brown. All the tibiae blackish at the base, the hind pair with much longer and denser hair and with the second pale ring more distinct. Apical pale mark on wing broader, and hind margin of wing with more conspicuous pale markings.

Length, 10 mm.; wing-length, 8 mm.; width of head, 3·5 mm.; width of front at vertex, 0·8 mm.

NYASALAND: Mpanda Mt., N. Nyasa, 20.xi.09 (*Dr. J. B. Davey*), 1 ♂ 8 ♀; forest on plateau near Mweynia, 18.xi.1909 (*Dr. J. B. Davey*), 1 ♀.

In coloration *H. rabida* is not at all unlike *H. torquens*, Aust., and *H. malefica*, Aust., but it differs very obviously from both in the characters of the antennae and the frontal callus. The coloration of the first antennal joint is most unusual.

Haematopota furians, sp. nov. (Pl. II, fig. 9).

♀. *Head* (fig. 9): Jowls rather dark grey; clypeus light brown, also upper part of face at sides; a dark brown patch on each side of the antennae. Front light brown more or less mottled with slightly darker brown, with short black hair; median spot absent; lateral spots rather small, round, not quite touching the eyes and without

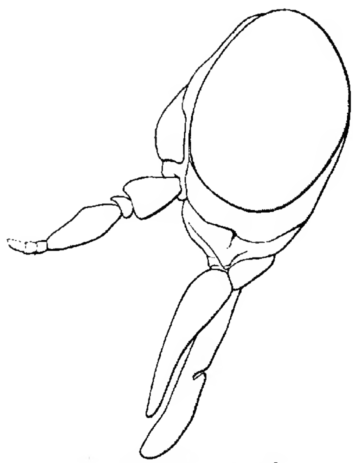


Fig. 9. *Haematopota furians*, Edw., sp. n.

pale borders. Frontal callus broad, nearly smooth, shining dark brown, not touching the eyes, its upper margin produced to a point in the middle. Spot below callus blackish brown. *Antennae* reddish brown, tip of last annulus of third joint black; first joint dull, very short, considerably swollen, less than twice as long as its greatest breadth. *Palpi* brownish, clothed with black hair.

Thorax rather dark brown with pale markings of the usual type which, though distinct, are not very conspicuous. Median stripe very narrow, usually extending the whole length of the scutum and over the scutellum; lateral stripes reaching the post-sutural spots. Scutellum with the tip sometimes grey, sometimes yellowish brown. Whole mesonotum clothed with mixed short black hair and yellowish close-lying pubescence. Pleurae dark brownish, clothed for the most part with dark hair.

Abdomen reddish brown, darker on the last few segments; all except the first two tergites have pairs of roundish light brown spots; there is also a narrow median light brown stripe running from the base of the second to the apex of the sixth segment, slightly broadened at the apex of the second; the hind margins of all the tergites are also distinctly light brown. Pubescence mostly blackish; pale on the venter and along the posterior, though not the lateral, borders of the tergites.

Legs brown; tarsi, except for the base of the metatarsi, somewhat darker. Front tibiae with one rather narrow and indistinct light brown ring near the base; middle and hind tibiae each with two rather indistinct light brown rings. Neither the front nor hind tibiae noticeably thickened.

Wings rather dark brown, markings light brown; stigma darker brown, except at the base. No darker clouds over the cross-veins. Squamae light brown. Halteres with whitish stem and brown knob.

Length, 11 mm.; wing-length, 9·8 mm.; width of head, 3·5 mm.; width of front at vertex, 1·0 mm.

SIERRA LEONE: Bo, iv–v.1910 (*Dr. H. E. Arbuckle*), 4 ♀ (including type); Batkanu Town, vii.1909 (*Dr. J. O. Murphy*), 1 ♀; Makump, 19.ix.1912, 2 ♀; Sandyallu, 3.viii.1912, 1 ♀; Senahu, 13.x.1912, 1 ♀ (*Dr. J. J. Simpson*); also one ♀ without exact data, presented by the London School of Tropical Medicine (coll. by *Dr. J. Pearson*).

H. furians is apparently most nearly allied to *H. sanguinaria*, Aust., from Rhodesia, and *H. edax*, Aust., from Uganda. Both these species differ in the shape of the frontal callus, which touches the eyes, in the shape of the third antennal joint, etc. Its nearest known relative in West Africa appears to be *H. torquens*, Aust., which differs in its smaller size; rather longer and less swollen first antennal joint; frontal callus touching eyes; pale-haired pleurae; less distinctly spotted abdomen; more conspicuous rings on tibae; dark squamae and lighter knob of halteres.

Haematopota perturbans, sp. nov. (Pl. II, fig. 2).

♀. *Head* (fig. 10): Face and jowls grey; a clearly-outlined blackish patch on each side of the antennae, nearly but not quite touching the eye-margins. *Front* light brown, with a pair of darker patches at the vertex; median spot absent; lateral spots rather large, round, not quite in contact with the eye-margins, without pale borders. Frontal callus rather narrow, shining black, slightly wrinkled, extending from eye to eye; its upper margin somewhat convex, with a narrow median projection, its lower margin concave above each antenna. Spot below callus blackish, rather narrow. *Antennae* reddish brown; the third joint blackish, except towards the base; first joint shining, considerably swollen, barely twice as long as its greatest breadth. *Palpi* brownish, clothed with black hair.

Thorax: Scutum dark brownish, with five distinct grey stripes running its whole length, the median stripe narrower than the others, the next pair more brownish behind the post-sutural spots; pubescence short, sparse, pale. Scutellum grey in the middle, sides dark brown. Pleurae greyish, nearly bare, a brown spot just above the sternopleural suture.

Abdomen rather dark brown, with a reddish tinge towards the base; posterior and lateral margins of tergites pale; pairs of indistinct pale spots on tergites 3–6; traces of a median pale line, most distinct on tergites 4 and 5. Pubescence mainly dark, some pale hairs along margins of tergites and on venter.

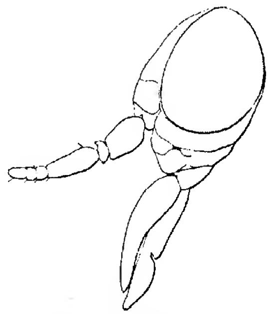


Fig. 10. *Haematopota perturbans*, Edw., sp. n.

Legs almost uniformly rather dark brown, tibiae without rings; front tibiae distinctly thickened. Pubescence black, except for some pale hairs on the under side of the hind femora.

Wings dark brownish, with well-defined very light brown markings; apical mark double. Squamae pale. Halteres with yellowish stem; knob brown, the tip lighter.

Length, 10 mm.; wing-length, 8·3 mm.; width of head, 3·1 mm.; width of front at vertex, 1·1 mm.

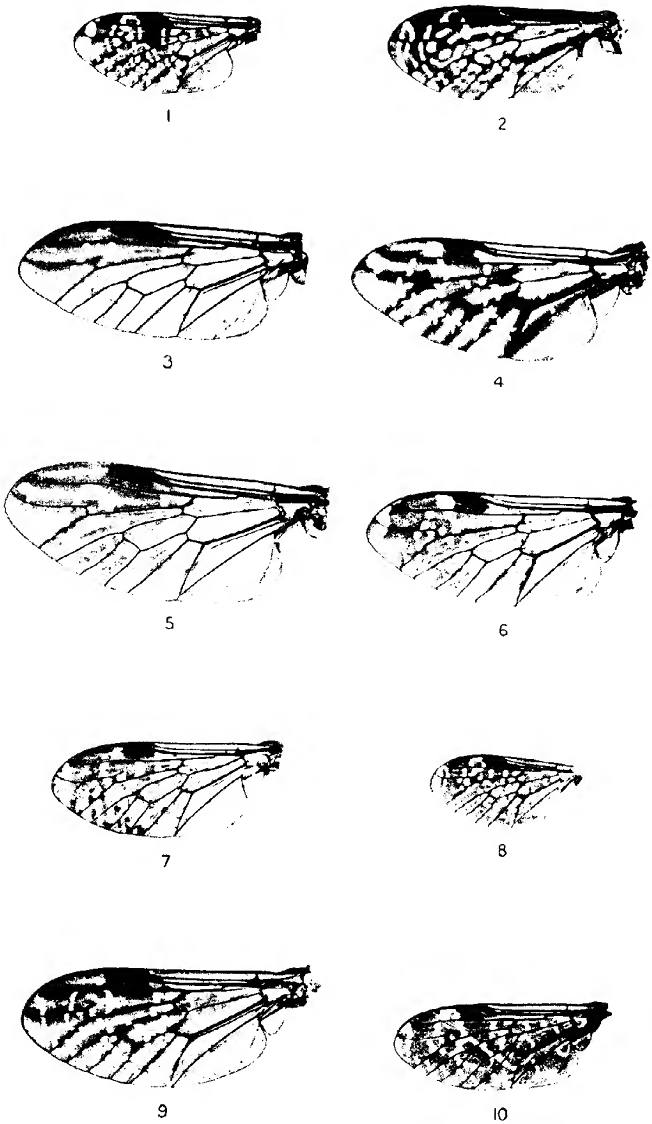
Congo: Zambi (*Van Saceghem*), 1 ♀ (type; presented to the British Museum by the Institut Pasteur, Paris); Upper Lubingo, 14.xii.1915, 2 ♀ (in coll. of Institut Pasteur).

H. perturbans is a very distinct species of the *H. pertinens* group. It differs from *H. pertinens*, Aust., in the more shining first antennal joint, black frontal callus, more distinctly striped thorax, partly reddish brown abdomen, rather darker legs, and in the wing-markings.

EXPLANATION OF PLATE II.

Fig. 1.	*Haematopota*	*crassicrus*,	Edw.,	sp. n.
2.	,,	*perturbans*,	,,	,,
3.	,,	*obsoleta*,	,,	,,
4.	,,	*pulchella*,	,,	,,
5.	,,	*nefanda*,	,,	,,
6.	,,	*fasciatapex*,	,,	,,
7.	,,	*rabida*,	,,	,,
8.	,,	*mordens*,	,,	,,
9.	,,	*furians*,	,,	,,
10.	,,	*pallidicornis*,	,,	,,

Each wing is magnified five times.



WINGS OF AFRICAN SPECIES OF *HÆMATOPOTA*.

THE DOMESTIC MOSQUITOS OF ACCRA.

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(Maps I & II.)

Samples of water containing mosquito larvae are collected at Accra by the Sanitary Inspectors, and are sent regularly to the Laboratory for identification. The number of samples submitted in this way is never very large, and varies considerably from time to time; but, recently, a careful examination has been made of all the specimens received during a complete year, and it is proposed to analyse in this paper the materials thus collected. In 1910–1911 Graham* made a similar study of the larvae found in native water-receptacles at Lagos, and it will therefore be interesting to compare our results with those obtained by him.

Accra, the capital of the Gold Coast Colony, is situated on the coast a few miles west of the meridian of Greenwich and about 330 miles north of the Equator. The town itself is divided into three portions, Accra proper to the west, Christiansborg where the Governor resides to the east, and the official residential area Victoriaborg between these two. The surrounding country is level for some miles, but the actual site of the town slopes slightly upwards as it recedes from the sea. Accra is a very dry and dusty town, almost completely denuded of vegetation. The rainfall is low; during the twelve months under consideration, December 1914 to November 1915, 21·75 inches of rain fell. During the same period the maximum shade temperature averaged 85·39°, the minimum 73·83°, and the relative humidity 72·46°. The physical features and climatic conditions of Accra differ therefore greatly from those of Lagos, a low-lying town surrounded by swamps with an average rainfall of about 70 inches.

Each of the samples containing mosquito larvae was marked with the number of the house and the division of the town from which it came. For the purposes of sanitary organisation Accra is divided into seventeen areas or blocks, and Christiansborg into seven. The positions of these are shown on the accompanying outline map (Map I). Victoriaborg is not divided into blocks, but each house is numbered. Practically, however, Victoriaborg may be disregarded, since with the exceptions of one or two samples all the larvae submitted had been found in the native compounds in Accra and the village of Christiansborg. A few samples were also collected from such situations as the lagoon and the Victoriaborg Reservoir and these are included in Table III, but are excluded from Table I, which summarises the identifications of the purely domestic mosquitos.

* Bull. Ent. Res., ii, p. 127.

During the twelve months selected for this investigation (December 1914 to November 1915), 417 samples containing mosquito larvae were submitted for examination (see Table I). For the first seven months a considerable number of samples were received monthly, but in July the numbers fell off abruptly and during the last three months very few indeed were submitted. Several causes may have contributed to bring this about. At the beginning of the investigation the co-operation of the Medical Officer of Health was obtained and he very kindly promised to send us as many samples as possible. This no doubt led to a stimulation of the Inspectors and consequently to an increase in the number of prosecutions, and as the fine imposed for harbouring mosquito larvae is a considerable one to the native, it probably brought about a greater care on the part of householders in the course of a month or two. The fact that we were away on leave from August until December may also have had a bearing on the case, as it may have been supposed that the maximum number of samples was no longer desired. On the other hand the falling off in the numbers might have been due to a seasonal variation in the incidence of the mosquitos themselves, but for the reasons stated later on we consider this to be improbable.

The Species of Mosquito Larvae Identified.

Ten different species of mosquitos were found in the 417 samples, namely, one Anopheline, four Stegomyias, and five other Culicines. *Stegomyia fasciata* was found in 373 of the samples (88·44 per cent.), *Culex fatigans* in 62 (14·86 per cent.), *Anopheles costalis* in 4 (0·95 per cent.), *Culex decens* and *Culiciomyia nebulosa* each in three (0·71 per cent.), *Stegomyia luteocephala* and *Stegomyia metallica* each in two (0·47 per cent.), and *Culex invidiosus*, *Culex tigripes* var. *fusca*, and *Stegomyia unilineata* each in one (0·23 per cent.). It is evident therefore that there were only two species that could be said to be common domestic mosquitos, namely *Stegomyia fasciata* and *Culex fatigans*, and that of these two the former preponderated.

Only six of the 417 samples were from Victoriaborg; all the rest were from native compounds. In the samples from Victoriaborg, however, six species were found, namely, *Stegomyia fasciata* and *Culiciomyia nebulosa* each thrice, *Stegomyia luteocephala* twice, and *Culex fatigans*, *Stegomyia metallica* and *Stegomyia unilineata* each once. Thus only seven species were found in the native compounds, namely, *Anopheles costalis*, *Culex decens*, *C. fatigans*, *C. invidiosus*, *C. tigripes* var. *fusca*, *Stegomyia fasciata* and *S. metallica*.

In 1,043 samples from the native compounds at Lagos Graham found six different species—*Stegomyia fasciata* in 92·5 per cent., (*Pectinopalpus fuscus*) *Culiciomyia nebulosa* in 21·6 per cent., *Culex duttoni* in 8·3 per cent., *Culex tigripes* var. *fusca* in 5·3 per cent., and (*Culex nigrocostalis*) *C. decens* and (*Pyretophorus costalis*) *Anopheles costalis* each in 1·8 per cent. It is interesting to contrast these results with those obtained at Accra. In the native compounds of both towns *Stegomyia fasciata* is by far the most common species. The only other species that was at all common at Accra, *Culex fatigans*, was not found at Lagos in a single sample; and *Culiciomyia nebulosa* which came second in Graham's list was not found in the native compounds of Accra although it was found thrice in Victoriaborg. The four species common to the two lists are *Anopheles costalis*, *Culex decens*, *Culex tigripes* var. *fusca* and *Stegomyia fasciata* (see Table II.).

TABLE 1.

The various species of mosquitos of which larvae were found during twelve consecutive months.

Month ..	Dec. 1914.	Jan. 1915.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov. 1915	Totals.	Percentages.
Number of samples submitted	45	56	51	62	40	42	68	18	15	4	10	6	417	
I.—Anopheline larvae.														
A. costalis in	..	..	..	2	..	..	..	1	1	..	..	..	4	0·95
II.—Stegomyia larvae.														
S. fasciata in	45	53	49	55	36	37	52	15	14	3	10	4	373	89·44
S. luteocephala in ..	..	..	..	..	..	2	..	..	..	..	..	..	2	0·47
S. metallica in	..	..	..	1	1	..	..	..	..	..	..	..	2	0·47
S. unilineata in ..	..	..	..	1	..	..	..	..	..	..	..	..	1	0·23
III.—Other Culicine larvae.														
C. decens in	..	..	..	2	1	..	..	..	..	..	..	..	3	0·71
C. fatigans in	..	5	4	8	5	6	27	4	..	1	..	2	62	14·86
C. invidiosus in ..	..	..	..	..	..	1	..	..	..	..	..	..	1	0·23
C. tigripes var. *fusca* in	..	1	..	..	..	..	..	..	..	..	..	..	1	0·23
Culiciomyia nebulosa in	..	..	..	2	..	1	..	..	..	..	..	..	3	0·71

TABLE II.

The percentages in which the larvae of the various mosquitos occurred in the native compounds at Accra (411 samples) and at Lagos (1043 samples).

Species of Mosquito.	Accra.	Lagos.
Anopheles costalis	1·0%	1·8%
Culex decens	0·7	1·8
Culex duttoni	..	8·3
Culex fatigans	14·8	..
Culex invidiosus	0·2	..
Culex tigripes var. *fusca*	0·2	5·3
Culiciomyia nebulosa	..	21·6
Stegomyia fasciata	90·0	92·5
Stegomyia metallica	0·2	..

In the Annual Report of the Medical Research Institute, Yaba, for the year 1914, Connal and Coghill summarise the results of their examinations of mosquito larvae sent to them from Lagos by Dr. Dalziel. The larvae of ten species were obtained, the six recorded by Graham, and in addition *Culex insignis*, *C. grahami*, *Ochlerotatus irritans*, and *O. nigricephalus*. It is not definitely stated, however, that all these species were found breeding in native compounds, and it is possible that some may not have been, for they specially mention the fact that *O. irritans* was found in crab-holes, a situation in which it occurs at Accra also.

Seasonal Distribution.

The number of samples examined at Accra during the twelve months from December 1914 to November 1915 was insufficient to reveal any seasonal variations, even if they had occurred, especially as there was such a marked falling off in the number of specimens during the last five months of the investigation. At the laboratory, however, there were records of the examinations of the larvae sent by the Medical Officer of Health extending back to 1912, and although these were imperfect and discontinuous it was found possible to summarise them broadly as identifications of Anopheline, Stegomyia, and other Culicine mosquitos. The examination of the larvae submitted during twelve consecutive months showed that *A. costalis* was the only Anopheline mosquito found in such samples, *S. fasciata* almost the only Stegomyia, and *C. fatigans* by far the most common other Culicine. If then there had been any marked seasonal variations in the incidence of these three species of mosquitos at Accra it would almost certainly have appeared in the combined results of the examinations of larvae for the four years 1912 to 1915.

TABLE III.

The monthly proportions in which larvae of the three types—Anopheline, Stegomyia, and other Culicines—have occurred in the samples (from all sources) sent for examination 1912 to 1915.

	Anopheline.					Stegomyia.					Other Culicines.				
	1912.	1913.	1914.	1915.	Totals.	1912.	1913.	1914.	1915.	Totals.	1912.	1913.	1914.	1915.	Totals.
January	..	..	..	1	1	..	..	12	53	65	..	..	10	7	17
February	..	..	..	..	0	..	..	150	49	199	..	..	30	6	36
March	..	..	1	2	3	..	7	33	57	97	..	..	8	14	22
April	..	1	3	..	4	..	28	20	37	85	..	6	2	9	17
May	..	..	1	..	1	..	20	12	39	71	..	..	3	8	11
June	..	..	..	..	0	..	2	..	52	54	..	4	..	27	31
July	..	..	..	1	1	..	..	..	15	15	..	..	..	4	4
August	..	..	..	1	1	4	1	..	14	19	2	1	..	..	3
September ..	..	..	..	..	0	15	1	..	3	19	9	1	..	1	11
October	1	2	..	..	3	28	29	..	10	67	5	17	..	..	22
November.. ..	..	2	..	..	2	21	11	16	4	52	..	6	8	2	16
December	..	..	..	..	0	3	16	45	7	71	1	7	..	1	9
Totals ..					16					814					199
Percentage..					1·6					79·1					19·3

TABLE IV.

Stegomyia larvae collected during 1915 distributed month by month according to the districts from which they came.

1915. Month.	Accra. Blocks— 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	?	Christiansborg. 1	2	3	4	5	6	7	?	Monthly totals.
January	2	2	1	1	1	2	2	1	..	..	1	3	2	2	1	4	12	1	2	1	8	2	..	2	..	..	53
February..	1	..	..	..	1	1	6	..	1	2	..	..	2	..	4	12	5	..	3	1	2	5	1	2	..	..	49
March	..	..	1	1	2	..	2	8	1	1	3	2	5	3	1	8	6	3	4	1	1	..	1	2	..	..	56
April	..	..	..	2	..	..	1	..	1	..	2	1	..	5	1	5	6	2	2	..	3	2	2	1	1	..	37
May	2	..	..	1	1	..	..	2	1	1	1	2	1	2	2	2	1	3	2	..	4	2	1	7	..	..	38
June	1	..	..	1	..	..	3	6	1	2	..	3	..	5	4	6	5	2	8	2	4	..	..	..	..	..	53
July	1	..	..	2	..	..	2	..	..	..	..	2	1	..	1	2	3	..	1	..	..	..	..	..	..	..	15
August	..	..	..	..	..	..	..	..	..	2	2	1	..	..	2	5	1	..	..	..	..	..	..	1	..	..	14
September	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	3
October	..	..	..	1	..	..	1	2	..	..	..	..	..	..	1	2	2	..	..	..	..	..	..	1	..	..	10
November	..	..	..	1	..	1	1	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	4
December	..	..	..	..	..	..	..	..	1	1	2	..	..	..	1	..	2	..	..	..	..	..	..	..	..	..	7
Totals	7	2	2	10	5	4	18	19	6	10	11	14	11	17	18	49	43	11	22	5	22	11	5	16	1	..	339
Grand totals ..	257																		82								

The monthly proportions in which larvae of the three types—Anopheline, Stegomyia, and other Culicine—have been found in the samples sent to the laboratory from all sources during the years 1912 to 1915 are shown in Table III. It cannot be said that any clear indication is given of seasonal variation, unless it is a diminution in the numbers of both Stegomyia and other Culicine mosquitos during July and August, that is just after the height of the rains. The very small number of Anopheline larvae identified during these four years indicates that their occurrence in the native compounds was incidental, as, indeed, might have been expected.

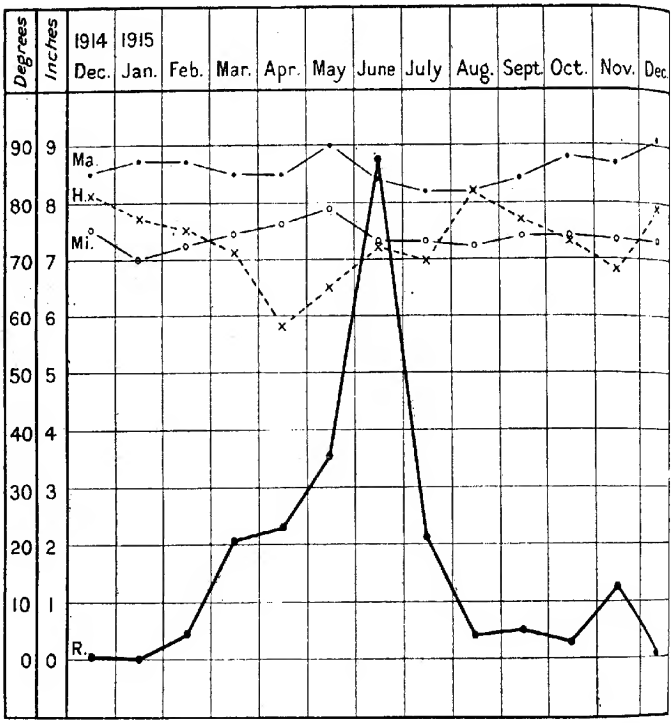
Table IV, which shows the distribution of the samples containing *Stegomyia* larvae during the year 1915, might also have given some evidence on this point. It records indeed a very marked falling off in the number of the samples from July onwards, but there does not appear to have been any condition associated with the rainfall, the temperature, or the humidity of the atmosphere (see Chart I) that would explain why a large number of larvae should have been found from December to June, but very few from July to November. On the whole it is probable that this diminution in the number of specimens submitted for examination was due to causes unassociated with the habits of the mosquitos, and with this exception the Table does not seem to show anything that might be interpreted as seasonal variation.

There is no great variation in temperature or humidity at Accra during the year, and domestic mosquitos are probably independent of the rainfall, since they breed in collections of water provided for them by the hand of man. There seems in fact to be no real reason why there should be any seasonal variation in the distribution of such mosquitos, and so far as the evidence here collected goes, there does not appear to be any such variation.

Other factors must of course be taken into consideration, such as a possible seasonal variation in the food supply of the larvae or in the numbers of their natural enemies. Such factors probably have but little influence on such dominant species of domestic mosquitos as *Stegomyia fasciata* and *Culex fatigans*. *Stegomyia fasciata* has been stated to breed mainly in clean water, and the presence of these larvae has even been regarded as a proof of purity. This popular error has been exposed by Boyce, and it may be mentioned that very many of the samples found at Accra were thriving in exceedingly impure fluids containing food refuse and various kinds of animal and vegetable debris. Neither *S. fasciata* nor *C. fatigans* is dependent on any particular species of algae for its diet. In the laboratory larvae of both these species have been bred in broth media which were sterile at the start, but of course became in a very short time rich cultures of bacteria. Provided the medium did not become actually foul-smelling, when the larvae perished, the richer it was, the larger (within narrow limits) the mosquitos that were bred from it. Few, if any, of the samples collected in the native compounds contained natural enemies visible to the naked eye; but Vorticellas, ciliates, flagellates, and other microscopical organisms were frequently seen when examining the larvae. Whether any of these organisms, or of the various bacteria found in water, are pathogenic or not seems to be uncertain. Vorticellas certainly accumulate in considerable numbers on larvae whose development has been delayed, and ciliates are usually found infesting the corpses of larvae that have died, but in any case it is unlikely that they would determine a seasonal variation in the mosquitos, since they are found in suitable samples of water all the year round.

CHART I.

The rainfall and mean temperatures and humidity at Accra from December 1914 to December 1915; Ma., maximum shade temperature; Mi., minimum shade temperature; H., relative humidity; R., rainfall.



The Distribution of the Larvae in the various Divisions of Accra and Christiansborg.

Accra is divided into seventeen blocks, and Christiansborg into seven. These areas are of different sizes and very different characters, some being crowded with small native compounds, others being almost rural. It seemed important therefore to determine whether there were any numerical or specific differences in the distribution of mosquitos in them. It would have been more instructive if the distribution could have been followed house by house, but this was found to be impracticable, owing to the alterations constantly taking place in the town.

The majority of samples containing larvae that were examined were labelled with the number of the block of the town in which they had been found. In the year 1915 it was possible to ascertain the exact block in which four out of the five samples containing Anopheline larvae were found, 328 out of the 339 in which Stegomyia larvae were found, and 65 out of the 76 in which other Culicine larvae were found.

Table V.

The specimens of larvae (1912–1915) distributed according to the areas from which they were derived.

Town ..	Accra.																	Christiansborg.							Totals.
Blocks ..	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.	xvi.	xvii.	i.	ii.	iii.	iv.	v.	vi.	vii.	
Stegomyia ..	13	3	11	22	22	7	33	38	15	19	50	28	19	30	41	88	65	24	5	31	11	10	21	1	610
Other Culicines	2	2	5	3	7	1	11	7	5	7	17	6	9	16	6	14	6	5	1	5	1	..	2	1	139
Anophelines ..	..	..	1	1	..	..	1	..	1	1	1	..	..	1	2	1	1	..	1	..	1	..	..	..	13
Totals ..	15	5	17	26	29	8	45	45	21	27	68	34	28	47	49	103	72	29	7	39	13	10	23	2	762

In the Annual Report of the Accra Laboratory for the year 1914 the records of the examinations of mosquito larvae from 1912 to 1914 were similarly dealt with and the distribution of the specimens amongst the various blocks was shown in tabular form. Nine samples containing Anopheline, 282 Stegomyia, and 74 other Culicine larvae were thus located. By combining these with the 1915 specimens we were able to locate the blocks in which 13 samples containing Anopheline larvae, 610 containing Stegomyia larvae, and 139 containing other Culicine larvae had been found (see Table V.).

The distribution of these samples is shown by means of conventional signs on the attached map (Map I). This map has been prepared from the latest map of Accra, and on it the various blocks into which the town is divided are marked and numbered, but for the sake of clearness almost all other features have been excluded. As the very small number of samples found to contain Anopheline larvae would have been entirely lost amongst the Stegomyias had each sample of larvae from each block been represented by a separate sign, some means had to be devised by which the numerical distribution of the larvae could be shown approximately without allowing one type to obliterate another. It was found that this could best be done by using one sign for every ten entries; thus one solid circle in any block indicates that Anopheline larvae have been found in this area, but that less than eleven such samples have been received, or two crossed circles in a block indicate that any number of samples of Stegomyia larvae from eleven to twenty have been received from this area. Both Anopheline and other Culicine larvae therefore figure in this map in undue proportions, but it was necessary to allow this to occur, as in their true proportions they would have been hardly distinguishable.

Looking at this map then we see that mosquitos breed most freely in the middle of Accra in the neighbourhoods of blocks iv and vii. This part of the town is crowded with native compounds, and is the most densely populated. In the outskirts of the town and in the village of Christiansborg relatively fewer larvae are found, a fact readily accounted for by the less congested nature of these districts.

With regard to the distribution of species, *Stegomyia*, which practically means *S. fasciata*, occurs in every block in proportions such that it altogether outnumbers all others. Culicine larvae, that is practically *Culex fatigans*, occur in smaller numbers in every part of Accra, and in six of the seven blocks of Christiansborg. Anopheline larvae, that is *Anopheles costalis*, on the other hand have only been found in very small numbers, once or twice in a block, but they have been received from all the blocks with the exceptions of blocks i, ii, v, vi, xii, and xiii of Accra, and blocks i, iii, v, and vii. of Christiansborg. How it is that *Anopheles costalis* comes to be found breeding in the compounds in water-receptacles is not quite clear. It has been suggested that owing to the arid nature of Accra the mosquitos are compelled to deposit their eggs on water contained in domestic vessels for lack of a more favourable situation, but there are in the neighbourhood of the town pools suitable for the breeding of Anopheline mosquitos, and in which as a matter of fact the larvae of *A. costalis* are generally to be found. Graham at Lagos similarly found this mosquito breeding in " the domestic pots and barrels of native yards," and as Lagos cannot be called arid, it seems probable that *A. costalis* does voluntarily breed in such situations. Graham, however, notes that there was a rise in the percentage of vessels

harbouring these larvae in February, and suggests that possibly this "was caused by the absence of suitable puddles or pools at the end of the dry season."

In the second map (Map II.) all the samples of larvae that were collected in native compounds during a complete year, 1915, so far as it was possible to locate them, are shown in full. so as to give some idea of both their actual numerical and specific distribution. Each conventional sign indicates one sample containing larvae of the particular species shown, and the signs in each block are distributed evenly, as it was not possible to localise the compounds accurately.

A Comparison of the Adult Mosquitos collected at Accra with the Larvae found breeding in the Compounds.

A large number of different species of mosquitos have been collected at Accra. According to the pamphlet entitled "Distribution of Mosquitos in West Africa," which was printed for the Yellow Fever (West Africa) Commission in August 1913, no less than thirty-one species had been recorded up to that time, and to these the collections made by us in 1915 added nine new names, bringing the total up to forty-one. These species were *Anopheles costalis*, *A. funestus*, *A. pharoensis*, *A. umbrosus*, *Culex decens*, *C. duttoni*, *C. fatigans*, *C. grahami*, *C. guiarti*, *C. insignis*, *C. invidiosus*, *C. ornatothoracis*, *C. quasigelidus*, *C. thalassius*, *C. thalassius* var. *fuscus*, *C. tigripes*, *C. tigripes* var. *fusca*, *Culiciomyia nebulosa*, *Cyathomyia* (*Protomelanoconion*) *fusca*, *Mansonioides africanus*, *M. uniformis*, *Micraedes inconspicuosus*, *Mucidus mucidus*, *Ochlerotatus albocephalus*, *O. irritans*, *O. domesticus*, *O. minutus*, *O. minutus* var. *biannulatus*, *O. minutus* var. *stenoscutus*, *O. minutus* var. *tarsalis*, *O. nigrocephalus*, *O. punctothoracis*, *Stegomyia fasciata*, *S. luteocephala*, *S. metallica*, *S. unilineata*, *Uranotaenia balfouri*, *U. connali*, *U. mashonaensis*, *U. mayeri*. Formidable as is this list, it is nevertheless incomplete, as we have found by the examination of some specimens collected recently. It is somewhat remarkable that of all these mosquitos known to occur at Accra only ten were represented in the samples of larvae from compounds sent for examination by the Medical Officer of Health.

Graham in his paper referred to above speaks of "The superior accuracy and finality obtained by dealing with the larvae breeding in the native yards" and states that by employing "this method of ascertaining the mosquito fauna of a native town . . . the results have proved more accurate and complete than those obtained by other methods." Whilst agreeing with him that "The catching of mosquitos in native yards and houses is difficult, and offers none of the advantages gained by dealing with the larvae," we cannot support his statements as to the accuracy and finality of the method in view of our experiences at Accra. It may be pointed out too that Graham's own study of the larvae found in domestic vessels revealed the presence of only six species (see above) at Lagos, although, quoting again from the pamphlet printed for the Yellow Fever Commission, forty-one species have been recorded as occurring in this town, namely, *Anopheles costalis*, *A. funestus*, *A. mauritianus*, *A. pharoensis*, *A. umbrosus*, *Aedomyia catasticta*, *Banksinella lineatopennis* (*luteolateralis*), *B. punctocostalis*, *Culex consimilis*, *C. decens*, *C. duttoni*, *C. grahami*, *C. insignis*, *C. invidiosus*, *C. quasigelidus*, *C. rima*, *C. thalassius*, *C. tigripes* var. *fusca*, *C. univittatus*, *Culiciomyia nebulosa*, *Eretmopodites inornatus*, *Mansonioides africanus*, *M. uniformis*, *Micraedes inconspicuosus*, *Mimomyia mimomyiaformis*, *Ochlerotatus caliginosus*, *O. domesticus*,

O. irritans, *O. longipalpis*, *O. nigricephalus*, *O. punctothoracis*, *Stegomyia africana*, *S. apicoargentea*, *S. fasciata*, *S. luteocephala*, *Taeniorhynchus annetti*, *T. aurites*, *T. metallicus*, *Toxorhynchites brevipalpis*, *Uranotaenia balfouri* and *U. mashonaensis*, and to these no doubt a considerable number of additions have been made since 1913.

During eight of the twelve months selected for this investigation, namely, from December 1914 to July 1915, one of us was living in a small bungalow not far from the laboratory (see Map) and collected all the mosquitos he could. Owing to preoccupation with other work no systematic collection was undertaken, but any mosquitos that obtruded themselves were secured if possible, and his servants were instructed to capture any that they they found in the kitchen and their sleeping room. In this way 280 specimens referable to fourteen species were collected, which are enumerated in Table VI, and beside them is placed a list of the larvae found breeding in compounds during the same period. The contrast is rather a remarkable one.

TABLE VI.

The mosquitos, arranged in order according to the frequency of occurrence, found at Accra, (*a*) as adults in bungalow A. 1, December 1914 to July 1915, and (*b*) as larvae in the samples sent to the laboratory by the Medical Officer of Health during the same period.

Adults.			Larvae.		
Species.	Number caught in bungalow.	Percentages.	Species.	Number of samples in which they were found.	Percentages.
Mansonioides africanus ..	129	46·0	*Stegomyia fasciata* ..	342	82·0
M. uniformis	81	28·9	*Culex fatigans* ..	59	14·1
Culex thalassius	31	11·7	*Anopheles costalis* ..	3	0·7
Anopheles pharoensis ..	11	3·9	*Culex decens*	3	0·7
A. costalis	10	3·5	*Culiciomyia nebulosa*.	3	0·7
Culex fatigans	6	2·1	*Stegomyia leuteocephala*	2	0·5
Anopheles funestus ..	3	1·0	*Stegomyia metallica* ..	2	0·5
Culex duttoni	2	0·7	*Culex invidiosus* ..	1	0·2
Ochlerotatus irritans ..	2	0·7	*Culex tigripes* var. *fusca*	1	0·2
Culex decens	1	0·3	*Stegomyia unilineata*	1	0·2
Culex insignis	1	0·3			
Culex invidiosus	1	0·3			
Micraedes inconspicuosus	1	0·3			
Stegomyia fasciata ..	1	0·3			

Only five species are common to the two lists, namely, *Anopheles costalis*, *Culex decens*, *C. fatigans*, *C. invidiosus*, and *Stegomyia fasciata*, and whereas *Mansonioides africanus* and *M. uniformis*, by far the commonest mosquitos in the bungalow, do not figure at all among the larvae, *Stegomyia fasciata* which heads the list of larvae is last on the list of mosquitos.

There were of course good reasons for these differences, some of which it was not difficult to ascertain. The bungalow in which the mosquitos were caught was situated in the European quarter, and no mosquitos were allowed to breed in the compound. There can be little doubt indeed that the considerable numbers of mosquitos usually to be found in this house must have come from a distance, as there was no place in the immediate vicinity where they could have been bred. But *Mansonioides africanus*, for example, is known to have a considerable range of flight, and as it breeds in pools in association with the water-weed *Pistia stratiotes*, it is natural that its larvae were never received in the samples collected in the compounds.

It is not easy to account for the rarity of *Stegomyia fasciata* in the bungalow. This mosquito, the house-haunting mosquito *par excellence*, which breeds in domestic water-vessels and is known to require feeds of blood for the maturation of its eggs, one would naturally expect to figure largely in any collections made in human habitations at Accra. In a bungalow in the European quarter, however, where every precaution is taken to prevent the breeding of mosquitos its absence might be explained, since it is said not to fly far, and in any case a long flight in search of blood must seldom be necessary for it. But recently a number (156) of mosquitos have been collected for us in a native's house in block xvii. of Accra, a locality in which *Stegomyia fasciata* abounds (see Table V. and Maps), and yet not a single specimen of this species has been caught up to the present.* It is possible that *Stegomyia fasciata* may prefer to bite in the open and may be disinclined actually to enter dwellings, but the occurrence of this mosquito in houses in large numbers has repeatedly been recorded by others, and one of us, in the Gold Coast, has frequently taken it in Europeans' bungalows in Ashanti and the Northern Territories, but usually in the afternoon between 3 and 6 p.m., and not at night. A more probable explanation of the facts recorded above is therefore that *Stegomyia fasciata*, whilst entering houses to obtain feeds of blood, does not roost indoors.

A consideration of the two lists shown in Table VI. convinces us that an examination of the larvae found in the compounds not only fails to give any adequate idea of the mosquito fauna of a town, but also fails to indicate the species of mosquitos to the attacks of which the inmates of the houses are liable. It also furnishes proof of the necessity for extending anti-mosquito measures so as to reach the species that breed far afield.

A Note on the Distribution of certain of the commoner Mosquitos found on the West Coast of Africa.

It is not easy to state what are the exact natural conditions which determine the presence of a particular species of mosquito in one locality and its absence from another. An adequate supply of food for the growing larva is generally regarded

*The mosquitos referred to have been identified as follows :—*Anopheles costalis*, *Culex fatigans* and *Mansonioides africanus*.

as the main factor. That this is the sole factor is unlikely, as already pointed out in this paper with regard to those larvae which are reared in domestic pots; for if it were, it would be difficult to account for the relatively greater frequency of *C. duttoni* amongst the domestic mosquitos of Lagos as compared with those of Accra, or to explain the presence of *C. fatigans* in considerable numbers amongst the domestic mosquitos of Accra and its absence from the collections made at Lagos. Again *C. tigripes* var. *fusca*, the larva of which is carnivorous and is not particular as to the species of larvae it preys upon, occurs in the proportion of 5·3 per cent. amongst the domestic mosquitos of Lagos, whereas its proportion is only 0·23 per cent. amongst similar mosquitos at Accra.

If the food supply of the larva is the preponderating factor in determining the distribution of the adult mosquito and if, as seems probable, the growth of the minute organisms, chiefly of a vegetable nature, which constitute the food of the larva are just as dependent upon varying conditions of atmosphere and the composition of the medium in which they grow as are the higher plants of the country, then it should be possible to indicate roughly in a table, which gives a return of the mosquitos taken in different districts that vary in their physical conditions, a corresponding variation in the distribution of the mosquitos. Table VII., which has been drawn up from the "Distribution of Mosquitos in West Africa" and from our own experience of the prevalence of certain species in different districts, is of interest in this connexion.

It has been shown by one of us* that certain mosquito larvae are very tolerant of salt in the medium in which they live. As there is a considerable amount of chlorides in Accra water, its presence may have some bearing on the anomaly in the distribution of *C. duttoni* and *C. fatigans* in this district. *C. fatigans* is capable of breeding in brackish water, while *C. duttoni*, according to Graham,† is intolerant of even a moderate amount of chlorides. Mosquitos such as *O. irritans* and *C. thalassius*, which breed by preference in brackish water, are not found far from the coast.

Graham‡ has pointed out that larvae of *A. costalis* failed to increase in size when placed in clear tank-water, but that growth proceeded upon the addition of small quantities of human urine (the addition of which may, however, have transformed the clear tank-water into a culture medium) which contains sodium chloride, and that the water of Accra and Sekondi, where *A. costalis* is the dominant Anopheline, is slightly brackish. *A. costalis* certainly appears to be more common on the coast than it is inland, where its place as a carrier of malaria is taken by *A. funestus* (*cf.* Stephens and Christophers).

Some mosquitos appear to flourish best in an atmosphere which is humid, e.g. *Eretmopodites*, *Toxorhynchites*, and *Taeniorhynchus*. Others such as *C. ager* var. *ethiopicus*, *C. consimilis*, and *C. annulioris*, the larvae of which are generally found embedded in flimsy algae, do not appear to be found on the coast. *Anopheles squamosus* and *A. rufipes* also seems to prefer inland stations, as does *Stegomyia sugens*. *Stegomyia fasciata* on the other hand is a lover of the coast, but as this is a domestic mosquito, the explanation of its wider distribution near the sea is probably that given by Boyce,§ who states that *S. fasciata* follows "the tin invasion which extends up from the coast to the interior villages," the discarded tins favouring the development of this particular species.

* Bull. Ent. Res., vi, p. 225. † Bull. Ent. Res., ii, p. 132.

‡ Report upon Entomological Observations made in Southern and Central Ashanti. 1907. p. 14. Colonial Office, Miscellaneous No. 236.

§ Bull. Ent. Res., i, p. 236.

TABLE VII.

The distribution of certain mosquitos. +++ indicates a very common species, ++ a common species, + a rare species, and — that the occurrence has not been recorded up to the present.

Mosquito.	Accra; arid, sandy soil, old sea bed. Rainfall, 29 ins.	Lagos; low-lying, swampy, surrounded by a lagoon. Rainfall, 71 ins.	Ashanti; thick forest except northern portion which is transitional. Rainfall, 56 ins.	Northern Territories; open orchard "bush." Rainfall, 47 ins.
Anopheles costalis	+++	+++	++	++
A. funestus	+	+	+++	+++
A. mauritianus ..	—	+	++	++
A. pharoensis	+	+	—	—
A. rufipes	—	—	+	+
A. squamosus	—	—	+	++
A. umbrosus	+	+	+	—
Aëdomyia catasticta	+	+	—	++
Banksinella lineatopennis ..	—	+	+	—
B. punctocostalis ..	—	+	+	—
Culex ager var. *ethiopicus* ..	—	—	+	+
C. annulioris	—	—	+	+
C. consimilis	—	—	++	++
C. decens	++	++	+	+
C. duttoni	+	++	+	++
C. fatigans	+++	—	—	—
C. grahami	+	++	++	+
C. insignis	+	+	++	—
C. invidiosus	+	+	+++	+++
C. quasigelidus	+	+	—	+
C. thalassius	+	+	—	—
C. tigripes var. *fusca* ..	+	++	++	++
C. univittatus	—	+	+	+++

TABLE VII.—*continued.*

Mosquito.	Accra; arid, sandy soil, old sea bed. Rainfall, 29 ins.	Lagos; low-lying, swampy, surrounded by a lagoon. Rainfall, 71 ins.	Ashanti; thick forest except northern portion which is transitional. Rainfall, 56 ins.	Northern Territories; open orchard "bush." Rainfall, 47 ins.
Culiciomyia nebulosa ..	++	+++	+++	+++
Cyathomyia fusca	+	—	—	—
Eretmopodites chrysogaster ..	—	—	++	—
E. inornatus	—	+	++	—
Mansonioides africanus ..	+++	+++	++	+++
M. uniformis	+++	+++	++	—
Micraëdes inconspicuosus ..	+	+	+	—
Mimomyia hispida	—	—	++	+
M. mimomyiaformis ..	—	+	+	+
M. plumosa	+	—	++	+
M. splendens	+	—	—	++
Mucidus mucidus	+	—	+	—
Ochlerotatus cumminsi ..	—	—	+	—
O. domesticus	+	+	+	—
O. irritans	+++	+++	—	—
O. minutus	+	—	+	—
O. nigeriensis	—	—	+	++
O. nigricephalus ..	+	+	—	—
Stegomyia africana	—	+	+	—
S. apicoargentea ..	—	+	+	—
S. fasciata	+++	+++	++	++
S. luteocephala	+	+	+	—
S. metallica	+	—	—	—
S. simpsoni	—	—	+	—
S. sugens	—	—	+++	+++
S. unilineata	+	—	—	—

TABLE VII.—*continued.*

Mosquito.	Accra; arid, sandy soil, old sea bed. Rainfall, 29 ins.	Lagos; low-lying, swampy, surrounded by a lagoon. Rainfall, 71 ins.	Ashanti; thick forest except northern portion which is transitional. Rainfall, 56 ins.	Northern Territories; open orchard "bush." Rainfall, 47 ins.
Taeniorhynchus annetti ..	—	+	—	—
T. aurites	—	+	—	—
T. metallicus	—	+	—	—
Toxorhynchites brevipalpis ..	—	+	+	—
Uranotaenia balfouri ..	+	+	+	+
U. connali	+	—	+	—
U. mashonaensis ..	+	+	+	—
U. mayeri	+	—	—	—

Summary and Conclusions.

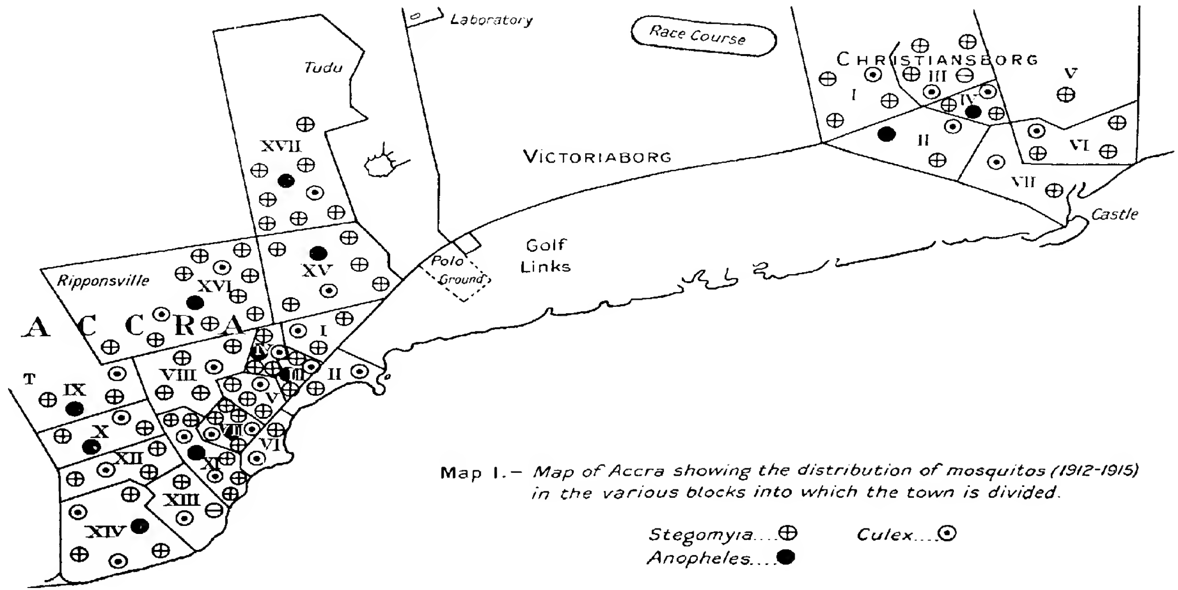
1. An examination of the mosquito larvae found in domestic water-receptacles, etc., in native compounds at Accra shows that two species, *Stegomyia fasciata* and *Culex fatigans*, predominate, and that of these the former is by far the most common.

2. Such an examination, however, fails to give a true idea of the mosquito fauna of the town, or of the species to the attacks of which the inhabitants are exposed. Many of the species most common in the houses do not breed in the compounds, but come from further afield, where their larvae should be sought out and destroyed.

* * * *

[With reference to the supposed non-existence of *Culex fatigans* in Lagos, Dr. J. M. Dalziel, who has recently been investigating the domestic mosquitos of that town has kindly supplied the following records of the occurrence of that species :—

"July 1914.	One adult caught in neighbourhood of the golf course marsh.
Sept. 1914.	One adult caught in Government House or environs.
Aug. 1915.	Bred from larvae from wells — twice.
Sept. 1915.	„ „ „ „ a well, with *Culex tigripes*.
Sept. 1915.	„ „ „ „ a boat, with *S. fasciata*.
Jan. 1916.	„ „ „ „ a well.
April 1916.	„ „ „ „ a canoe."—Ed.]



Map I.– *Map of Accra showing the distribution of mosquitos (1912-1915) in the various blocks into which the town is divided.*

NOTES ON SOME ANIMAL PARASITES IN BRITISH GUIANA.

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(Map III.)

British Guiana lies between the latitudes 0·41′ N. (source of the Essequebo River) and 8° 33′ 22″ N. (Punta Playa), has a depth from north to south of about 500 miles, a seaboard of about 270 miles trending in a south-easterly direction, and occupies in the north-east of South America an area approximately equal in extent to Great Britain. It is bounded on the north by the Atlantic Ocean, on the east by Surinam or Dutch Guiana, on the south and south-west by Brazil, and on the west by Venezuela.

The Colony may be divided broadly into three belts.* The northern one consists of a low-lying flat and swampy belt of marine alluvium—the coastal region. This rises gradually from the seaboard and extends inland for a distance varying from 5 to 49 miles. It is succeeded by a broader and slightly elevated tract of country of sandy and clayey soils. This belt is generally undulating, and is traversed in places by sand-dunes rising from 50 to 180 ft. above sea-level. The more elevated portion of the Colony lies to the southward of the above-mentioned regions. It rises gradually to the south-west, between the river valleys, which are in many parts swampy, and contains three principal mountain ranges, several irregularly distributed smaller ranges, and in the southern and eastern parts numerous isolated hills and mountains. The eastern portion is almost entirely forest-clad, but on the south-western side there is an extensive area of flat grass-clad savannah land elevated about 300 feet above sea-level.

British Guiana has at times been described as an unhealthy country. This is an undeserved calumny, as is clearly shown by the statistics of mortality of European races other than Portuguese. For those who lead regular lives and do not expose themselves to unnecessary risks the climate is decidedly a healthy one. The coast-lands are swept throughout the year by the north-eastern trade winds, which add greatly to the comfort, vigour and health of those resident thereon. The mean annual rainfall near the coast is about 94 inches, and further inland about 105 inches. The average mean shade temperature at or near the coast-lands for the past twenty-two years is 80·0 F. The average mean maximum is 85·1 F., and the average mean minimum 74·9 F. The greatest annual range is about 19 F.

*These notes on the geography and climate of the Colony have been reprinted from an article on the field and forest resources of British Guiana in Bull. Imperial Institute, xiii. No. 2, April–June, 1915, p. 203.

During past years entomology, economic or otherwise, has received but slight attention from residents in British Guiana. A number of scattered references to the subject appear in the leading entomological publications of several countries, but in the main these are the results of visits or expeditions to the Colony of professional collectors, and only occasionally the work of local amateurs.

With a very few exceptions all the species and observations recorded in this article are the outcome of our own work during the last two-and-a-half years, which has been carried out as opportunities occurred. No paid local collectors have been employed, as we have found that as soon as the financial element is introduced they rapidly become untrustworthy and little or no faith can be placed in their observations.

We are indebted to Mr. A. A. Abraham, Agricultural Instructor in charge of the Government Experiment Station in the North West District, who has on several occasions sent small collections of Tabanidae and Mallophaga from this part of the Colony together with careful observations regarding their habits. Also to Mr. S. H. Bayley, the Superintendent of the Onderneeming Industrial School, for several species of parasitic worms from the livestock kept on the farm.

Mr. M. A. de Freitas, of the British Guiana Museum, has kindly assisted in procuring several species of lice from birds collected by himself for the preservation of their skins in the Museum collection. Material has been obtained from all the important agricultural areas and from some of the more remote inland districts.

Identifications are in every way reliable for they have been made through the co-operation of the Imperial Bureau of Entomology by specialists either in the British Museum or elsewhere.

Methods of Collecting.

The collecting of parasites is not always an easy matter. Opportunities for collecting have a habit of occurring at most inconvenient times, which necessitates the constant carrying of a suitable equipment. Fortunately this need not be cumbersome and the following short notes on methods of collecting and the equipment used, which we have found to meet all requirements in actual practice, may prove of interest to other entomologists engaged in similar work in the tropics.

For capturing various species of lice a pair of forceps about 10 cms. in length with fine rounded points having a perfectly smooth gripping surface will be found useful. The part which in use is held between the fingers should have a milled surface so as to afford a firm hold.

A flat tin box of a convenient pocket size with partitions to hold about a dozen medium-sized tubes containing alcohol and stoppered with well-fitting corks is also necessary. Paper and pencil should always be carried, as it is most important that data concerning the host, date, locality, and other particulars of interest should be accurately recorded at the time of actual collection. The piece of paper containing these notes should be enclosed in the tube along with the specimens.

For capturing TABANIDAE and other bloodsucking Diptera a net is of course necessary, but an individual possessed of a quick eye and a steady hand can accomplish much without it.

Tabanidae, especially when feeding, can often easily be captured by carefully placing over them a killing tube; as soon as the fly finds itself imprisoned it will fly up into the tube and the cork may then rapidly be inserted, or else the tube may be held over the insect *in situ* while the cyanide does its work; with a restive animal however this is not always possible.

A convenient-sized tube for this work is one about 8 cms. in length and 3 cms. in diameter and of good quality thick glass. The cork should fit well, but not too tightly, or trouble will be experienced in its withdrawal; it should be well waxed externally.

Small pieces of cyanide mixed with a somewhat larger quantity of boracic acid powder are placed in the bottom of the tube and rammed well down; a thin layer of cotton wool follows also well rammed down, and finally about 3 or 4 disks of thick blotting paper, cut out slightly larger than the diameter of the tube so that they fit tightly when pressed down and thus prevent the entire mass from shifting. The boracic powder prevents the cyanide from deliquescing and also seems slightly to stimulate its action. The whole mass should not occupy more than about 3 cms. of the length of the tube.

A further advantage of this method lies in the fact that when the cyanide becomes exhausted it can easily be removed and the tube recharged; anyone who has used the plaster of Paris and cyanide method of charging killing bottles is familiar with the difficulties and inconveniences of recharging, especially in the damp atmosphere of the tropics, which hastens the deliquescence of the cyanide.

Ticks are easily collected by means of the forceps, though care should be taken in removing them, so as not to leave the mouth-parts embedded in the cuticle of the host.

Lice are often hard to find, especially on birds, but experience will in time indicate the most likely parts of the body on which to search.

When examining poultry and other kinds of birds better results will be obtained if a person is employed to hold the bird firmly in a convenient position while a careful examination is being made.

A pair of small but sharp scissors often prove useful for the entire removal of a feather or feathers infested with lice. The specimens can afterwards be removed in the laboratory with a certainty and exactness seldom possible under field conditions.

Parasitic Worms.

Our investigations in connection with parasitic worms, carried out principally among domestic animals, have revealed a highly interesting field of almost unlimited scope. A curious feature is the comparative rarity of tapeworms among the ordinary creole dogs. We have never encountered them during our *post mortem* examinations and only very rarely have the cast mature segments been observed.

The determinations have in all cases been made by Mr. H. A. Baylis, Department of Zoology, British Museum. Unfortunately, in some cases the specimens were not sufficiently well preserved to allow of a certain identification. A number of other worms have been collected from various hosts, but owing to the present European conditions we have been unable to get them identified.

Class NEMATODA.

Family FILARIDAE.

Filaria cervina, Duj. A single specimen of this parasite was obtained from the abdominal cavity of a cow at the Georgetown Abattoir. It does not appear to be a common species.

Filaria physalura, Bremser. Some splendid specimens of this large worm were taken from the Collared Kingfisher (*Ceryle torquata*), a large bird of common occurrence. Several specimens were taken from the connective tissue about the neck, while the heart was enveloped with a large specimen which had coiled itself tightly around this organ. We are indebted for this specimen to Mr. M. A. de Freitas, who secured it while on a collecting expedition in the upper reaches of the Demerara River.

Filaria immitis, Leidy. It would probably be a difficult matter to find a creole dog over two years in age which does not harbour this parasite. Dogs about two years old generally possess at least one adult worm in the heart itself or in the pulmonary artery. In old dogs a thick tangled mass of the worms is often found in these organs, which would appear to choke them completely. However, the presence of this parasite seems to have but little effect on the general well-being of the dog. Imported dogs seem to thrive and are not rapidly killed by this worm as has been reported from China. The mosquito, *Culex fatigans*, Wied., is the probable vector of the disease.

Filaria sp. Large numbers of a filarial worm were taken from the body cavity of the White-breasted Swallow (*Tachycineta albiventris*). Poor preservation of the specimens rendered an exact determination impossible.

Family ASCARIDAE.

Ascaris megalocephala, Cloquet. One specimen of this large worm was obtained from a horse after the administration of a purgative.

Family STRONGYLIDAE.

Ankylostoma sp. A common species, resembling *A. ceylanicum*, Loos, in the intestine of most dogs. As many as 15 of these worms have been taken from one dog.

Physaloptera ? praeputialis, Linst. An exceedingly common parasite in the stomach of most cats. From 4 to 12 of these worms are usually found firmly attached to the stomach wall. Lutz has recorded the occurrence of this parasite in Brazil in the same host.

Class PLATYHELMINTHES.

Dicorcelium sp., near *D. lanceatum*, Stiles & Hassall. This parasite seems to be extremely prevalent among cats in the colony. At times the liver will be found to be very heavily infested, while in other cases only a few flukes will be found.

Class CESTODA.

Moniezia expansa, Rud. This species was taken from a pig at the Georgetown Abattoir. It is not normally a parasite of the pig, but it is possible that in some manner or other the worm as excreted from its original host may have been consumed by this animal, as pigs are notorious eaters of all kinds of refuse and filth.

Class ACANTHOCEPHALA.

Echinorynchus gigas, Goeze. This appears to be a common inhabitant of the small intestine of pigs in British Guiana; numerous specimens have, on various occasions, been obtained from pigs slaughtered at the Georgetown Abattoir.

Class ARACHNIDA.

Order *ACARINA*.

Family IXODIDAE.

In British Guiana all kinds of live-stock are attacked by various species of ticks, which are in many cases directly responsible for a very considerable annual financial loss. Preventive measures, such as dipping, are quite unheard of and the presence of these pests is universally regarded with the utmost indifference.

Argas persicus, Wald. This tick is a common inhabitant of fowl-houses throughout the Colony, and the larvae are to be found on most varieties of poultry. The larval stage of this tick is known locally as " Nimbles."

Rhipicephalus sanguineus, Latr. One of the commonest external parasite of dogs. All stages of development may be found on this animal. Between the digits and within the ears are favourite points of attachment.

Margaropus annulatus var. *australis*, Fuller. Flourishes on all kinds of cattle. Steers that have been in the pastures for a few months soon become heavily infested and thereby loose weight and condition. Instances have been observed where several ticks have attached themselves to the eyelids and engorging there caused intense irritation. The death of a calf through tick infestation is not uncommon. The institution of properly constructed dipping or spraying contrivances would handsomely repay the initial outlay. This tick has a number of other hosts, including the common toad or " Crapaud " (*Bufo marinus*).

Amblyomma cajennense, F. Locally known as the Balata Tick. In certain districts of the coast-lands, usually near the rivers or creeks and also within the forest area, this tick is commonly met with as a parasite of man. In these infested areas after traversing but a few miles as many as a dozen of these ticks will often be found attached to different parts of the body. Unless carefully removed an irritating spot is left which will prove troublesome for some months.

Amblyomma humerale, Koch. This tick has been twice taken from turtles and on both occasions some distance inland. The points of attachment are the softer and unarmoured parts of the head and neck, especially about the eyes and mouth. Some 24 specimens were taken from a single turtle.

Amblyomma dissimile, Koch. This species is a common parasite of cold-blooded animals, such as toads, lizards, and many varieties of snakes. It is widely distributed. The ordinary toad (*Bufo marinus*) invariably bears several specimens attached to the head immediately between the eyes and occasionally on the back. These ticks are especially numerous after the heavy rainy seasons in January and usually again in May. A single engorged specimen fully half-inch in diameter was on one occasion taken from a Salampenta (*Turpinambis nigropunctatus*). We have also taken this species from the Iguana (*Iguana tuberculata*).

Class HEXAPODA.

Order *DIPTERA.*

Family Tabanidae.

Within the coastal region the Tabanidae are of common occurrence, though they are chiefly composed of large numbers of a few common species. Within the forest areas, however, these coast-land species seldom appear and their place is taken by numerous other species, some of which are comparatively rare. According to information received, the savannah lands near the Brazilian border are particularly rich in Tabanidae, but up to the present no opportunity has occurred for collecting or making definite observations within this area.

The common species of Tabanidae that attack live-stock on the coast-lands belong to the genus *Tabanus*—*T. trilineatus*, Latr., *T. senior*, Wlk., and *T. semisordidus*, Wlk.; of these *T. trilineatus* is possibly the commonest and most widely distributed.

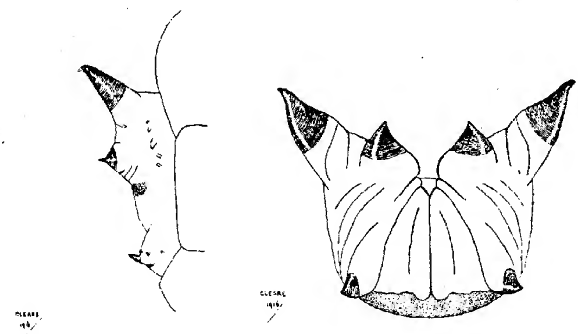


Fig. 1. Pupal aster of *Tabanus desertus*, Walk., ♀: lateral and posterior aspects.

The numerous muddy trenches and ditches that are necessary for drainage purposes all over the coastal area, and more especially in the cultivated portions such as the sugar estates, provide very suitable breeding places for these flies, but very little is known of their life-histories; a wide and fascinating field for research is thus presented.

The egg-masses of *T. semisordidus*, Wlk., have been observed to be deposited on the leaves of aquatic grasses and in some instances on the leaves of young rice plants. They are laid in a neat little bundle consisting of some 20 or more cigar-shaped shining black eggs adhering to one another and to the leaf surface.

The larval and pupal stages of *T. desertus*, Wlk., have been observed by us. Numbers of the larvae were found in a damp accumulation of sweepings situated at the end of a drain leading from a large cattle pen. Several of these larvae were secured and kept in the laboratory under frequent observation. Although supplied with a quantity of suitable food the largest larva eventually consumed its companions and pupated. After 16 days a female *Tabanus desertus* emerged.

A recent outbreak of Mal de Caderas (*Trypanosoma equinum*) amongst the sugar plantation mules was in all probability propagated by biting flies, and most of the common species of TABANIDAE and other biting flies, such as the well-known *Stomoxys calcitrans*, L., were observed to feed freely on mules afflicted by this deadly equine disease.

The principal enemies of TABANIDAE are several species of the large predaceous wasps belonging to the Bembecinae. These, owing to their characteristic yellow and black coloration and fierce habits, have received the peculiar Creole name of "Cowfly tiger." On the coast-lands the commonest species are *Monedula signata*, Latr., *M. punctata*, Lep., and *M. surinamensis*, Dahlb., while in the forest area the formidable *M. pantherina*, Handl., is frequently met with. *Bembidula discisa*, Tasch., and *Bembidula variegata*, Ol., are also encountered in this region.

Wherever TABANIDAE occur, large numbers of these wasps will be observed to be active, especially round cattle and mules when in the pastures. Despite the loud buzzing flight and active darting movements of their enemies, the TABANIDAE seldom display any concern at their presence, though they take good care to choose those portions of their host least exposed to the manœuvres of the wasps. They are always more numerous on sandy soils, which provide greater facilities for their nesting habits.

The Asilid fly, *Mallophora calidus*, F., is also an occasional enemy of TABANIDAE in the coastal area; owing to its size however it is capable of attacking only the smaller species.

Dicranomyia cervus, Wied. A not uncommon species in some of the interior districts. Readily attacks man.

Chrysops tristis, F. This is a common species and is widely distributed throughout the coastal region, it is occasionally met with in the forest area. It has a very distinct tendency to attack man, and owing to its stealthy method of approach, the first indication of its presence is usually the sharp pain caused by the insertion of its proboscis, generally in some exposed part of the back of the neck. It is a shade-loving species and is most active during the early morning hours and at eventide.

Chrysops costata, F. Only met with in certain districts where the soil is of a sandy nature and in the proximity of large areas of fresh water. It has the same tendency to attack human beings as *C. tristis* and has much the same method of approach.

Chrysops fulviceps, Wlk. Apparently only encountered in the forest area, and nothing is known of its habits.

Bolbodimyia bicolor, Big. Apparently an uncommon species. One specimen was taken while attacking man in the North West District.

Lepidoselaga crassipes, F. One specimen of this handsome fly has been taken on the coast-lands while attacking man.

Diachlorus scutellatus, Macq. (fig. 2), *D. podagricus*, F., *D. curvipes*, F. These three species at certain times of the year are extraordinarily abundant. and during these periods they become a most obnoxious pest, owing to their persistent and bloodthirsty attacks on human beings. Their habitat is in the forest areas, especially near the rivers in the North-West District.

Dichelacera damicornis, F. This fly has a distinct partiality for the blood of human beings and has much the same method of attack as *Chrysops*. It is found only within the forest area.

Dichelacera testacea, Macq. Within the forest area this is a common species and will readily attack man. Its bite produces considerable local irritation and swelling.

Tabanus senior, Wlk. This fly is much like *T. semisordidus*, Wlk., in appearance and habits, and in the field they may easily be mistaken for one another. *T. senior* is commonly found about stock of all kinds in the pastures throughout the year and is a particularly voracious and bloodthirsty species. It is capable of inflicting a severe wound with its large and lancet-like proboscis, and instances have been observed where the repeated wounds caused by this species have caused the legs of mules and cattle to bleed freely. It has a very rapid and noisy flight, but when once settled down and feeding it is easily captured and may even be picked off by hand. No instance has come under observation of its attacking human beings.

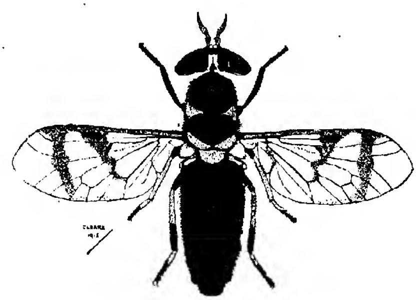


Fig. 2. *Diachlorus scutellatus*, Mcq. ♀, × 5.

Tabanus semisordidus, Walk. Has the same habits as the previous species, the two frequently occurring together.

Tabanus impressus, Wied. In size this is slightly larger than the two previous species and has much the same appearance, but it is of rarer occurrence. It appears to be widely distributed, and on several occasions has been known to attack man.

Tabanus imponens, Wlk. Only one specimen of this fly has been captured and nothing is known of its habits or life-history.

Tabanus trilineatus, Latr. The common Tabanid of British Guiana, and it appears to be distributed over both the forest and coastal area. It is not so voracious as *T. semisordidus* and specimens are usually captured while resting on foliage. No instance has been observed of its attacking human beings. It frequently is attracted to artificial light.

Tabanus desertus, Wlk. (fig. 3). The feeding habits of this fly have never been observed, though numbers have been collected from time to time. It appears to be a peculiarly inert species and is attracted by artificial light.

Tabanus caiennensis, F. This species is very occasionally met with on the coast-lands while attacking stock. In some of the interior districts it is common and readily attacks man.

Tabanus leucaspis, Wied. Of rare occurrence within the forest area, where it has been observed to attack man.

Tabanus ochroleucus, Mg. This peculiar Tabanid is frequently taken in human habitations, being attracted there by artificial light. It has been known to attack man.

Tabanus trifascia, Wlk. Closely allied to *T. trilineatus* and with very similar habits.

Tabanus oculus, Wlk. One specimen of this insect has been taken in the interior districts while attacking man.

Family Anthomyidae.

Mydaea pici, Macq. The larvae of this fly are subcutaneous parasites of birds, such as the Kiskadee (*Pitangus sulphuratus*) and the Twa-Twa Slave (*Aryzoborus torridus*) on the coast-lands.

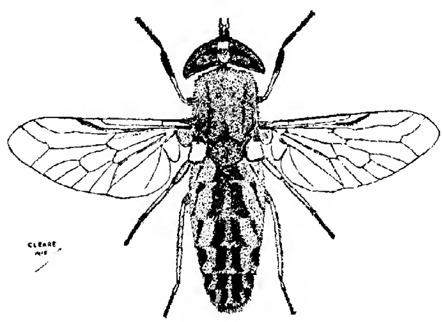


Fig. 3. *Tabanus desertus*, Walk., ♀, × 4.

Family Muscidae.

Stomoxys calcitrans, L. In all parts of the coastal area and in many of the inhabited areas of the inland regions this fly is of common occurrence. About stables in Georgetown, and particularly about the mule stables and compounds on the sugar estates, numbers of these flies are continually active, more especially in the early morning and evening hours. In the absence of other food supplies it will readily attack human beings and often proves most irritating. No decided increase in its numbers has been observed at any special season of the year.

Family Hippoboscidae.

A number of these flies are known to infest different kinds of birds and some mammals, but their activity, and the manner in which they quickly leave their host at its death, renders their capture extremely difficult.

Lynchia maura, Bigot. Frequently found on domestic pigeons.

Order *SIPHONAPTERA*.

Family SARCOPSYLLIDAE.

Dermatophilus penetrans, L. This well-known species is widely distributed over the Colony. They are known locally as Jiggers or Chigoes.

Family PULICIDAE.

Ctenocephalus felis, Bouché. Probably the commonest species on the coast-lands. It is the common flea of domestic cats and dogs and occasionally attacks man.

Order *RHYNCHOTA*.

Family CIMICIDAE.

Cimex hemiptera, F. (*rotundatus*, Sign.). This species is the common bed-bug of British Guiana.

Order *ANOPLURA*.

Family PEDICULIDAE.

Pediculus capitis, de Geer. A parasite of Negros, East Indians, etc., in the Colony. The colour varies slightly according to the host.

Pediculus humanus, L. This species is not nearly so frequently met with as the former. It has been collected solely from East Indians. They are much lighter in colour than *P. capitis*, being a whitish grey. They are known locally as "white lice" and are said to be most voracious in their habits.

Phthirius pubis, L. Is found as a parasite of all the different races inhabiting British Guiana.

Family HAEMATOPINIDAE.

Haematopinus eurysternus, Nitzsch. Collected from cattle on the coast-lands. It is the common cattle louse.

Haematopinus tuberculatus, Nitzsch. This species was collected from imported Indian buffaloes, which apparently are the only hosts in British Guiana.

Haematopinus suis, L. Very common on pigs. It was collected several times on these animals at the Georgetown Abattoir.

Order *MALLOPHAGA*.

This order is well represented in British Guiana. From the economic standpoint the presence of ill-kept and overcrowded fowl-houses and pigeon-lofts and pens of a like character for sheep and goats accounts largely for the abundance of these parasites and for their wide distribution among domestic animals.

Some species of birds in the wild state appear to be heavily infested with lice, while others again are almost entirely exempt.

Family TRICHODECTIDAE.

Trichodectes pilosus, Gieb. On donkey (*Equus asinus*).

Trichodectes climax, N. On goat (*Capra hircus*).

Trichodectes sphaerocephalum, N. On sheep (*Ovis aries*).

Family PHILOPTERIDAE.

Philopterus breviformis, Kell. & Kuw. From *Progne chalybdea*, the common swallow of the coast-lands in British Guiana.

Philopterus duplicatus, Piag. From *Ceryle torquata*, a common species of Kingfisher on the coast-lands.

Philopterus obscurus, Gieb. From *Rostrhamus sociabilis*, a common species of Snail-eating Buzzard, and also from a Peacock (*Pavo cristatus*) in the Botanic Gardens, Georgetown.

Degeeriella sp. From the White-breasted Harrier Eagle (*Herpetotheres cachinnans*) and *Rostrhamus sociabilis*.

Paragoniocotes abnormis, Kell. From a small undetermined species of coast-land parrot.

Family GONIODIDAE.

Goniocotes curtus, N. From *Opisthocomus cristatus*, the well-known Hoatzin or Canje Pheasant.

Goniocotes gigas, Taschb. (= *abdominalis*, P.). Parasite of chickens (*Gallus domesticus*) and turkeys (*Meleagris domestica*).

Goniocotes hologaster, N. From pigeons (*Columba domestica*) and guinea-fowls (*Numida meleagris*).

Goniodes dissimilis, N. From chickens and turkeys.

Goniodes compar, N. From pigeons.

Goniodes pavonis, L. From a Peacock (*Pavo cristatus*) in the Botanic Gardens, Georgetown.

Goniodes stylifer, N. From turkeys.

Family LIPEURIDAE.

Lipeurus assessor, Gieb. From *Rostrhamus sociabilis* and *Cathartes perniger*.

Lipeurus baculus, N. From pigeons.

Lipeurus leucopygus, N. From Blue Heron.

Lipeurus polytrapezius, N. From chickens.

Lipeurus squalidus, N. From Muscovy duck and *Herpetotheres cachinnans*.

Lipeurus variabilis, N. From chickens, guinea-fowl and turkey.

Lipeurus sp. From the Blue Gaulding (*Florida coerulea*).

Family MENOPONIDAE.

Menacanthus sp. From *Rostrhamus sociabilis*.

Menacanthus sp. From *Opisthocomus cristatus*.

Menopon biseriatum, P. From turkey (*Meleagris domestica*).

Menopon pallidum, N. From *Gallus domestica*, *Numida meleagris*, and *Meleagris domestica*.

Menopon macropus, Gieb. From *Crax alector*.

Myrsidea rustica, N. From *Progne chalybdea*.

Colpocephalum dissimile, Piag. From *Rostrhamus sociabilis*, and also from the Caraow (*Aramus scolopaceus*).

Colpocephalum sp., near *importunum*, N. From a Chow (*Butorides striata*) and Blue Heron.

Colpocephalum maculatum, Piag. From the Brown Caracara Hawk (*Polyborus cheriway*), *Herpetotheres cachinnans*, *Rostrhamus sociabilis*, and the Gory-headed Kiskadee or Tyrant Bird (*Tyrannus melancholicus*).

Colpocephalum phaeostomum, N. From *Pavo cristatus* in the Botanic Gardens, Georgetown.

Colpocephalum sp. From *Pavo cristatus*.

Colpocephalum, N. From *Columba domestica*.

Family Physostomidae.

Physostomum angulatum, Kell. From *Tyrannus melancholicus*.

Physostomum sp. From *Polyborus cheriway*.

Family Laemobothriidae.

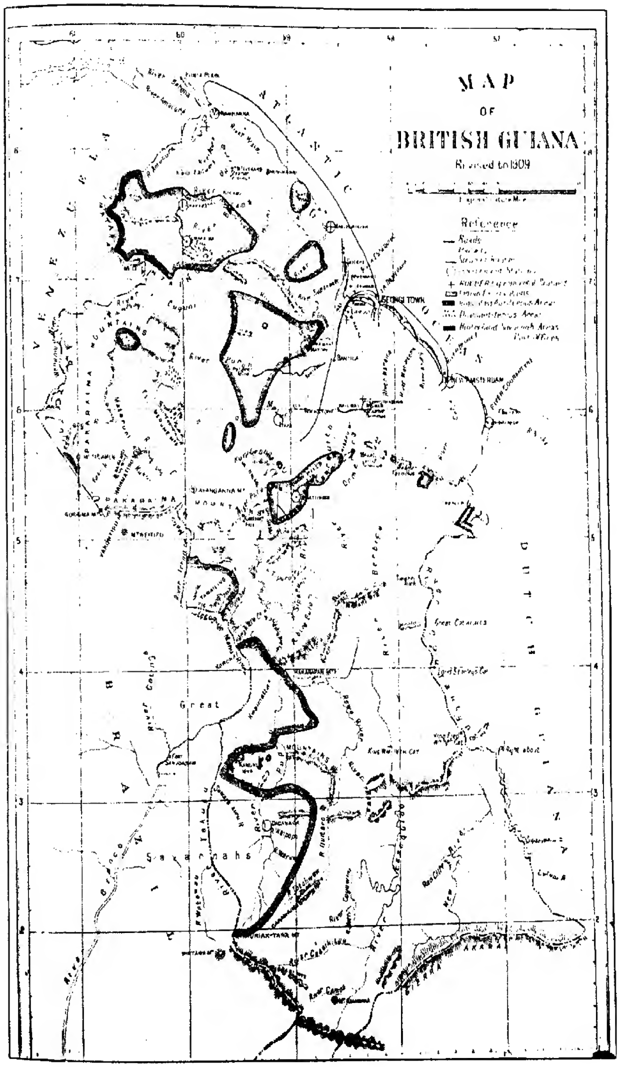
Laemobothrium opisthocomi, Cummings. From Hoatzin (*Opisthocomus cristatus*).

Laemobothrium sp. From Caraow (*Aramus scolopaceus*). These birds are always heavily infested with this species.

Family Gyropidae.

Gyropus ovalis, N. From guineapigs (*Cavia porcellus*).

Gliricola gracilis, N. From guineapigs.


MAP
OF
BRITISH GUIANA
Revised to 1909
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VENEZUELA
ATLANTIC
GEORGE TOWN
NEW AMSTERDAM
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Great
Savannahs
Great Cataracts

ON THE GENUS PHLEBOTOMUS—PART III.

By Professor R. NEWSTEAD, F.R.S.

Phlebotomus major, var. **chinensis,** var. n.

This variety differs from the description of *P. major* given by Annandale* by the relatively greater length of the proximal segment of the superior claspers, and, also in the male, in having the second, third, and fourth segments of the palpi of equal length. There are also slight colour differences in both sexes, but little importance can be attached to such a variable character.

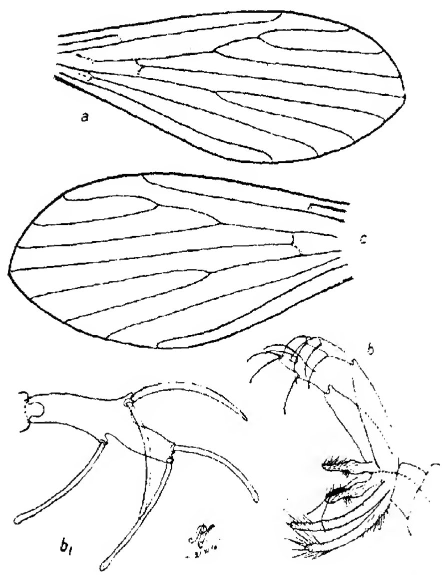

Fig. 1. *Phlebotomus major* var. *chinensis*, Newst.: *a*, wing of ♂, × 78; *b*, genital armature, × 100; *b₁*, superior claspers, × 450; *c*, wing of ♀, × 78.

♂.—Abdominal hairs more or less erect dorsally; those at the sides recumbent; colour variable: dull greyish to bright golden ochraceous or similar to those in *P. papatasii*, Scop. Costal hairs either of the same colour as those on the rest of the wing and body or smoky brown. Third segment of the antennae reaching to the tip of the proboscis; geniculated spines present, those on the seventh to twelfth, inclusive, relatively very short. Palpi with the second, third and fourth segments

* Records Ind. Mus., iv, p. 46.

equal in length; fifth very long, about two-and-a-half times as long as the fourth, and more slender than the others. Wings (fig. 1, *a*) slightly narrower than those of the female. Genital armature (fig. 1, *b*, b_1) with the proximal segment of the superior claspers nearly four times the length of the last, free, abdominal segment; spines of superior claspers (fig. 1, b_1) slightly spathuliform; tips of inferior claspers extending beyond the mid articulation of the superior claspers.

Length, 3·3–3·5 mm.; wing: length, 2 mm.; greatest width, 0·6 mm.

♀.—Arrangement of abdominal hairs similar to that in the male; the hairs generally much darker than those of the other sex, more especially so are those on the costa of the wing. Third segment of the antennae reaching to the middle of the proboscis. Palpi with the second, third and fourth segments subequal; fifth about two-and-a-half times as long as the fourth. Wings (fig. 1, *c*) slightly broader than those of the male. Abdomen markedly attenuated distally; the inferior appendages being separated from the superior pair by a space equal in length to the width of the segment to which they are attached.

Length, 3·2 mm.; wing: length, 2·2 mm.; greatest width, 0·75 mm.

CHINA: Wo Fu Su Temple, Western Hills, Peking, 1–6. vii. 14; Ting Chou, twelve miles E. of Peking, ? 1914 (*Dr. R. A. Bolt*).

Phlebotomus sp.

Five examples, all females. A relatively robust and a very dark-coloured species with all the abdominal hairs recumbent. This may ultimately prove to be new and undescribed, but males are needed and pairs taken in coitu are a special desideratum.

CHINA: Wo Fu Su Temple, Western Hills, Peking, 1–6. vii. 14; Ting Chou, near Peking, ? 1914 (*Dr. R. A. Bolt*).

June 22nd, 1916.

NOTES ON COCCIDAE OCCURRING IN THE SEYCHELLES ISLANDS, WITH DESCRIPTIONS OF NEW SPECIES.

By E. E. Green, F.E.S., F.Z.S.

The new species, described below, have been received from Mr. R. Dupont, Superintendent of Botanic Stations in the Seychelles.

Aspidiotus (Chrysomphalus) ansei, sp. nov. (fig. 1).

Female puparium irregularly circular or broadly ovate; flattish or moderately convex. Very pale brownish ochreous, semitransparent; pellicles darker, central. Diameter averaging 1·45 mm.

Male puparium smaller and more distinctly ovate; pellicle nearer one extremity. Length 1 mm.

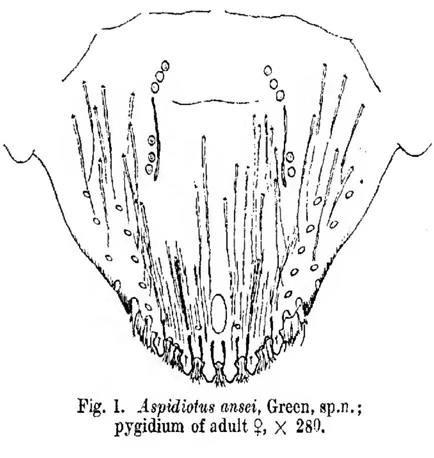

Fig. 1. *Aspidiotus ansei*, Green, sp.n.; pygidium of adult ♀, × 280.

Adult female broadly rounded in front, narrowed and bluntly pointed behind. Margins of abdominal segments moderately produced. Pygidium (fig. 1) with six well developed prominent rounded lobes, the median pair indented on each side, the two lateral lobes more conspicuously indented on the outer side. Squames long and deeply fimbriate: two in each of the median and first lateral spaces, three in the second lateral space, and three beyond the outer lateral lobe, followed immediately by a stout marginal prominence, beyond which the margin is slightly cristate for a short distance. Spines few, small and inconspicuous. Paraphyses, four on each side, elongate, conspicuous. Anal orifice near the extremity. Circumgenital glands in four groups: upper laterals with 3 to 4 pores, lower laterals with 2 to 3. Oval dorsal pores in two series on each side. Numerous long slender ducts communicating with the dorsal and marginal pores. Length, 1 mm.

Nymphal pellicle indented at each side between the cephalic and thoracic areas. Pygidium with five conspicuous elongate paraphyses on each side. Length, 0·65 to 0·7 mm.

Crowded on fronds of *Cocos nucifera*. Anse aux Pins, Seychelles.

Gymnaspis grandis, sp. nov. (fig. 2).

Female puparium (fig. 2, *a*) consisting of the naked nymphal pellicle, which is approximately hemispherical, jet black and highly polished. Diameter, 1·5 mm.

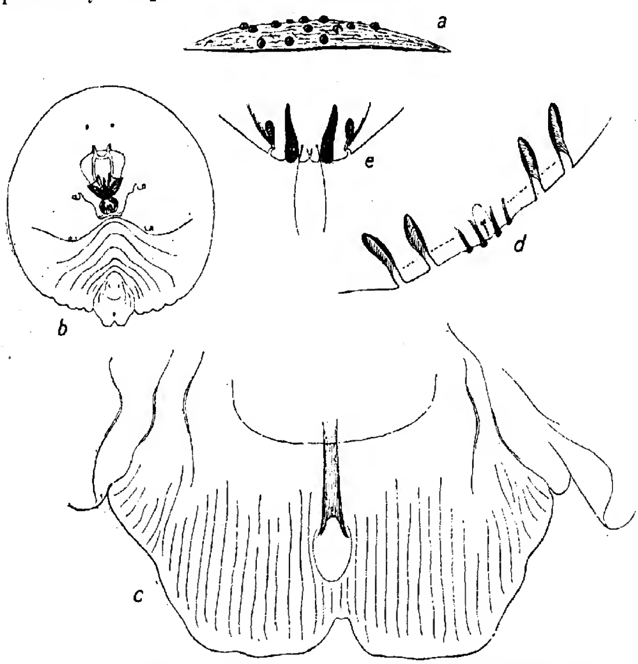

Fig. 2. *Gymnaspis grandis*, Green, sp. n.; *a*, group of puparia, nat. size; *b*, adult ♀, × 30; *c*, pygidium of adult ♀, × 280; *d*, posterior margin of nymphal pellicle, × 135; *e*, posterior margin of embryonic larva, × 280.

Adult female (fig. 2, *b*) circular, the pygidium slightly projecting. Rostrum large, densely chitinous. Pygidium (fig. 2, *c*) with posterior margin quite simple, devoid of lobes, spines or processes of any kind: a moderately deep median marginal indentation. Anal orifice near the extremity. Genital orifice covered by a chitinous fold. There are no circumgenital glands or pores of any kind. Diameter of female (under compression) 1·25 to 1·5 mm.

Posterior extremity of nymph (fig. 2, *d*) with four small simple lobes which scarcely project beyond the margin but are extended inwards, disposed close together. Outside the lobes, on each side, are two large, deep and conspicuous clefts, which probably represent modified marginal pores.

Posterior extremity of embryonic larva (fig. 2, *e*) with two lobes, on each side of which is a single deep cleft. Length of embryo, 0·5 mm.

On fruit of "Coco de Mer" (*Lodoicea sechellarum*). Praslin, Seychelles.

Lepidosaphes duponti, sp. nov. (fig. 3).

Puparium of female (fig. 3, *a*) ochreous brown to dark brown. The older (and darker) examples have the median longitudinal area flattened or even slightly concave, the depressed area bordered on each side by a more or less well marked ridge which is usually of a deeper colour than the other parts of the scale. Outside this ridge the sides fall away sharply and then expand into a narrow flattened margin. Other

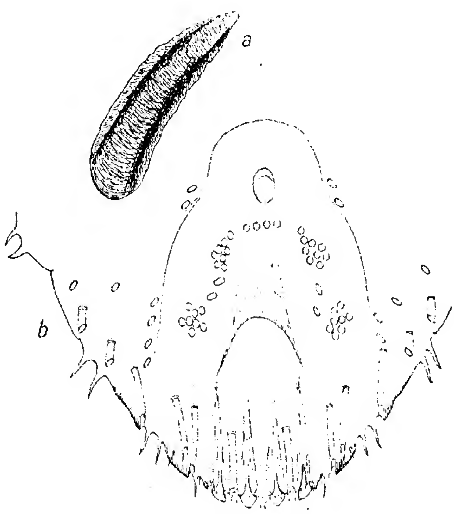

Fig. 3. *Lepidosaphes duponti*, Green, sp. n.; *a*, puparium of ♀, × 15; *b*, pygidium of adult ♀, × 280.

examples do not show this marked depression, but the darker lateral bands are indicated. The form may be approximately straight, or variously curved and contorted. Length, 2·5 to 3 mm. Greatest breadth approximately 1 mm.

Male puparium paler, with traces of lateral darker bands: no median depression. Length, 1·5 mm.

Adult female of normal form: broadest across the base of the abdomen. Lateral margins of abdominal segments moderately produced. Marginal area of metathorax and abdomen with numerous small dorsal pores which are more thickly disposed on the first two segments of the abdomen. Pygidium (fig. 3, *b*) with well developed median and first lateral lobes, the latter being duplex, the inner lobule large and broadly expanded, the outer lobule small and narrow. A broad cristate prominence on each side, shortly beyond the lateral lobes. Pointed tubular squames in the usual

positions. Circumgenital glands in five groups: median group with from 3 to 5 pores (usual number 4), upper laterals 6 to 9 (average 8), lower laterals 7 to 9 (average 8). Length averaging 1·25 mm.

On leaf stalks of Coconut Palm. Silhouette, Seychelles.

The species is characterized by the exceptionally large inner lobule of the duplex lateral lobes, which equals the median lobes in size. I am not sure if the depression of the female puparium is a normal character, or whether it has been caused by pressure between adjacent leaf stalks. It was noticeable that the flattened examples were grouped at the lower end of the stalk.

Since the publication (in Trans. Linn. Soc. Lond., xii, part 2, p. 197, 1907) of a list of Coccidae occurring in the Seychelles, the following species have been identified in collections received from Mr. Dupont:—

Lecanium mangiferae, Green: on Cinnamon and imported Mango plants.

Aspidiotus dictyospermi pinnulifera, Mask.: on *Jasminum*, *Thunbergia*, *Pandanus* and Coconut.

Aspidiotus bromeliae, Newst.: on Pine-apple plants.

Aspidiotus ansei, Green: on *Cocos nucifera*.

Ischnaspis filiformis, Dougl.: on Oil Palm.

Gymnaspis grandis, Green: on *Lodoicea* (Coco de Mer).

Parlatoria pergandei, Comst.: on *Thunbergia*.

Lepidosaphes duponti, Green: on *Cocos nucifera*.

The list of species recorded from these islands is still a very small one, and the number of genera represented is extraordinarily poor. It includes *Icerya* (1 sp.), *Asterolecanium* (2), *Pseudococcus* (2), *Pulvinaria* (2), *Ceroplastes* (1), *Vinsonia* (1), *Lecanium* (7), *Chionaspis* (1), *Hemichionaspis* (2), *Diaspis* (1), *Aspidiotus* (8), *Lepidosaphes* (4), *Ischnaspis* (1), *Gymnaspis* (1) and *Parlatoria* (1); a total of 15 genera and 35 species only. Such widely distributed genera as *Orthezia*, *Antonina*, *Eriococcus* and *Fiorinia*, are as yet unrepresented.

A NEW WEEVIL ATTACKING PINE-APPLES IN JAMAICA.

By Guy A. K. Marshall, D.Sc.,

Director, Imperial Bureau of Entomology.

Mr. A. H. Ritchie, Government Entomologist of Jamaica, has recently sent home specimens of a large black weevil which he has found doing serious damage to pine-apples in that island. The insect proves to be a new species of *Metamasius*, of the sub-family Calandrinae, and I have much pleasure in naming it after its discoverer.

Metamasius ritchiei, sp. nov. (fig. 1).

Colour uniformly black, without any scaling, hairs or bloom; the prothorax rather shiny, the elytra duller, the metasternum and the middle of the venter very shiny.

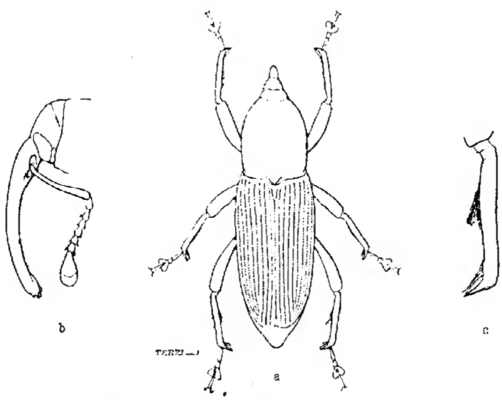

Fig. 1. *Metamasius ritchiei*, Mshl., sp. n., ♂; *a*, dorsal view; *b*, side view of head; *c*, hind tibia.

♂.—*Head* shiny, with very small scattered punctures, its outline not continuous with that of the rostrum (fig. 1, *b*); the distance between the eyes above slightly greater than usual, the space between them beneath with a very shallow triangular impression. *Rostrum* stout, strongly curved, longer (across the curve) than the front femur and shorter than the prothorax, thickened at the base, then very gradually narrowing to near the apex and widening again slightly; the whole surface rather shiny and with small scattered punctures throughout, a small round fovea in the middle of the extreme base and a short faint central stria between the antennae; the mentum convex and rather prominent, so that the rostrum is markedly deeper at the apex. *Antennae* with the funicle nearly as long as the scape, the two basal joints equal, 4 to 6 subequal and about as long as broad; the bare triangular portion of the club (as seen from the broad side) with its lateral edge longer than the apical, which is rounded, the pubescent terminal portion almost semicircular. *Prothorax*

a little longer than broad (7 : 6), the sides almost parallel from the base to the middle, thence narrowing in a curve and with a well-marked subapical constriction, the basal margin with a rather pronounced median lobe, bordered by a distinct carina which is not continued beyond the lobe; the upper surface quite flat with very minute scattered punctures, except along a narrow central line in the basal half, and a few coarser punctures at the extreme apex of the basal lobe. *Scutellum* lancet-shaped, impunctate, deeply hollowed at the base to receive the prothoracic lobe. *Elytra* much longer than the prothorax (12 : 7), broadest at the shoulders and very gradually narrowed behind, striae 1 to 6 narrow and impunctate, wider and deeper at the base, the outer striae with rows of small shallow punctures becoming finer and shallower at the base, the intervals almost flat, with minute irregular punctures. *Sternum*: the prosternum coarsely punctate, except the space between and behind the coxae, which is impunctate, the punctures diminishing towards the sides; the inter-coxal piece of the mesosternum impunctate, the remainder and the side-pieces with shallow separated punctures; the metasternum very shiny and with very minute scattered punctures, the side-pieces more opaque. *Venter* in the middle similar to the metasternum, but with the punctures a trifle more evident and becoming much stronger towards the sides, the last segment with a shallow depression at the apex containing coarse confluent punctures. *Legs* with fine scattered punctation; coxae with a small tuft of reddish hairs; the femora with a few minute hairs on the lower surface; the tibiae with two carinae on the lower edge each bearing a fringe of hairs, those on the mid tibiae short, on the front pair longer, on the hind pair short with a conspicuous tuft of long hairs in the middle (fig. 1, c).

♀ unknown.

Length (excluding rostrum), 19·5–20·5 mm.; breadth, 7–7·5 mm.

Jamaica: Above Rocks District (*A. H. Ritchie*).

Although this insect has a somewhat different appearance from that of any other species of *Metamasius*, it presents all the essential characters of the genus indicated by Mr. G. C. Champion (Biol. Cent. Amer., Ins. Col. iv, pt. 7, p. 103). It lacks the characteristic torpedo-like shape; the prothorax is broader and flatter than in the other species, the basal lobe is more pronounced, and the restriction of the basal carina is peculiar, for in all the other forms it extends almost or quite to the posterior angles; and finally, in the normal species the mentum has a shallow longitudinal impression.

Mr. Ritchie states that all the pine-apple growers are agreed that this weevil made its appearance in the district, which is one of the best pine-producing areas in the island, about four years ago, and has grown steadily worse until this year, when it is estimated that 75 per cent. of the pines have been lost. As a rule, plant pines are not attacked, and it is principally ratoon pines that are damaged, only one ratoon crop being grown. According to Mr. Ritchie's observations the plants may be attacked at various points. Sometimes the root stock is bored, or again the fruit stalk is hollowed out and collapses; a favourite place of attack is the junction of the fruit and stalk, when the grub proceeds into the fruit and riddles it, or the heart may be attacked before the pine-apple has shot above the leaves.

In addition to the black weevil Mr. Ritchie found numerous specimens of a brown weevil, *Metamasius sericeus*, Oliv., but he is of the opinion that presence of this species is merely secondary, it being attracted from the surrounding bananas by the decaying pines killed by *M. ritchiei.*

COLLECTIONS RECEIVED.

The thanks of the Imperial Bureau of Entomology are due to the following gentlemen, who have kindly forwarded collections of insects (between 1st January 1916 and 31st March 1916) :—

Dr. W. M. Aders :—2 Muscidae and 4 tubes of intestinal worms ; from Zanzibar.

Mr. C. Beeson, Imperial Forest Zoologist :—about 700 Chalcids ; 19 Braconidae and their cocoons ; and 2 Proctotrupidae ; from Dehra Dun, India.

Mr. G. E. Bodkin, Government Economic Biologist :—15 Diptera ; 45 Ants ; 33 other Hymenoptera ; 31 Coleoptera ; 2 Moths ; 4 Planipennia ; 17 Rhynchota ; 21 Odonata ; 15 Orthoptera ; 4 spiders and a number of worms ; from British Guiana.

Mr. M. T. Dawe :—2 imagines of the fly *Dermatobia hominis* and 1 *Sarcophaga* fly bred from a Locust ; from Colombia.

Mr. d'Emmerez de Charmoy, Government Entomologist :—4 Coleoptera ; from Mauritius.

Division of Entomology, Pretoria :—14 Coleoptera ; from South Africa.

Director, South African Museum :—5 Moths ; from South Africa.

Mr. P. R. Dupont, Curator of the Botanic Station :—50 Coleoptera and a number of Coccidae ; from the Seychelles.

Mr. C. French, Jr., Government Entomologist :—A number of Coccidae; from Victoria.

Mr. C. C. Gowdey, Government Entomologist :—2 Culicidae ; 37 other Diptera ; 3 species of Thysanoptera ; 10 Braconidae ; 550 other Hymenoptera ; 967 Coleoptera ; 16 Lepidoptera ; about 100 Aphids ; 2 boxes of Coccidae ; 478 other Rhynchota ; 37 Orthoptera ; 1 tube of ticks and 1 tube of intestinal worms ; from Uganda.

The Governor of Jamaica :—18 imagines, 2 larvae and 4 pupae of *Cosmopolites sordidus* ; from Jamaica.

Mr. P. L. Guppy :—3 Hymenoptera ; 57 Lepidoptera and 3 cocoons ; and 19 Scorpions ; from Trinidad.

Mr. W. Harris, Superintendent of Public Gardens :—18 Cistelid beetles and 9 Coleopterous larvae ; from Jamaica.

Mr. G. F. Hill, Government Entomologist :—4 Cecidomyiidae ; 5 other Diptera ; 619 Ants, 32 larvae, and 32 pupae ; 1 Ants' nest ; 3 Planipennia ; a large number of Coccidae ; 13 Cercopid bugs ; and 1 Mantid ; from the Northern Territory of Australia.

Dr. W. A. Lamborn :—A large number of *Glossina morsitans* pupa-cases ; 24 other Dipterous puparia ; 42 other Diptera ; about 140 Chalcids ; 230 other Hymenoptera ; 116 Coleoptera ; 2 Coleopterous larvae ; 36 Lepidoptera ; 2 Chrysopidae ; 51 Rhynchota ; 6 Odonata ; and 1 spider ; from Nyasaland.

Mr. S. Leefmans, Laboratorium von Plantenzeikten, Buitenzorg:—31 Capsid bugs; from Java.

Mr. Ll. Lloyd, Government Entomologist:—About 600 *Glossina morsitans* puparia and 6 larvae; 5 Bombyliidae and 3 larvae; 153 Chalcids; 65 other Hymenoptera; from Northern Rhodesia.

Mr. C. Mason, Government Entomologist:—1 Asilid and Orthopterous prey; 10 Tabanidae; 2 Hippoboscidae; 42 other Diptera; 4 Braconidae; 9 Coleoptera; 34 Lepidoptera; 9 Rhynchota; 2 Forficulidae; from Nyasaland.

Dr. J. W. Scott Macfie:—33 Culicidae; 10 other Diptera; 24 Fleas; 1 Ant Lion; a number of Coccidae; 11 Spiders; 2 Ticks; 20 Mites and 7 Leeches; from the Gold Coast.

Prof. G. H. F. Nuttall, F.R.S.:—17 *Phlebotomus*; 2 *Culex fryeri*; 1 beetle and 2 Reduviidae; from Mombasa.

Mr. W. H. Patterson, Government Entomologist:—About 400 Thrips and a number of Coccidae; from the Gold Coast.

Mr. A. H. Ritchie, Government Entomologist:—6 *Cosmopolites sordidus*; from Jamaica.

Mr. H. Scott:—6 Coleoptera of two species; from Nyasaland.

Dr. J. J. Simpson:—24 Tabanidae; 2,808 *Glossina*; 197 Hippoboscidae; 408 other Diptera; 542 Hymenoptera; 359 Coleoptera; 4 Ant Lions; 228 Rhynchota; 146 Orthoptera and 51 Odonata; from the Northern Territories of the Gold Coast.

Dr. A. T. Stanton, Government Bacteriologist:—104 Culicidae and 33 larvae; and 14 other Diptera; from the Federated Malay States.

Mr. Robert Veitch:—6 Diptera; 1 Ant; 8 Coleoptera; 8 Lepidoptera; 2 Tettigoniidae and 1 spider; from the Fiji Islands.

Dr. H. Werkman, Government Medical Officer:—44 Culicidae; from Java.

Wellcome Bureau of Scientific Research:—67 Diptera; 40 Hymenoptera and 1 Beetle; from Colombia.

Dr. J. Y. Wood, W.A.M.S.:—4 Tabanidae; 70 Culicidae; and 95 *Glossina* from Sierra Leone.

Mr. Shin-ichiro Yamada:—477 Culicidae; from Japan.

NOTES ON CULICIDAE, WITH DESCRIPTIONS OF NEW SPECIES.

By F. W. Edwards, B.A., F.E.S.

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Genus Anopheles, Mg.

A. (Coelodiazesis) plumbeus, Hal.

The life-history of this species has recently been fully described by Christophers (Ind. Jl. Med. Res., iii, Jan. 1916, p. 489) from larvae obtained in tree-holes in the neighbourhood of Simla. It is somewhat surprising that a species of *Anopheles* should have such a wide range, especially since tree-breeding mosquitos are usually more local in their distribution than other kinds. I believe, however, that Christophers was perfectly correct in his conclusion that *A. barianensis*, James, is the same species as *A. plumbeus*, Hal.

I had on several occasions looked in vain for larvae of *A. plumbeus* in tree-holes and elsewhere, until in April last I succeeded in finding numbers of larvae, associated with those of *Ochlerotatus geniculatus* (see below) in holes in beech trees at Burnham Beeches, Bucks. These larvae agree closely with Christophers' description and figures, the only difference I can detect being that the " triradiate spines " to which Christophers refers do not seem to be so strongly developed.

The larvae were kept for a fortnight in the water in which they were found, together with some of the leafy debris which it contained, but they appeared to make no growth at all. The same was true of specimens which were isolated in tubes without debris, but with small larvae of *O. geniculatus*. After this lapse of time fragments of crushed flies were added to the tubes and also to the main receptacle. All the *Anopheles* larvae at once clustered round and fed voraciously, some of them pupating very shortly afterwards. These experiments entirely confirm Christophers' conclusion that the larvae depend mainly for their food upon insects which fall into the water of the tree-holes; they do not appear to feed, as does *O. geniculatus*, on the vegetable debris at the bottom; nor, it seems, do they attack these other larvae, although the latter were always present in the tree-holes in which I found *A. plumbeus*.

According to Dyar and Knab, the larvae of the North American *A.* (*Coelodiazesis*) *barberi* prey upon those of *Aëdes* (*Ochlerotatus*) *triseriatus* (which is the North American representative of *O. geniculatus*). From this difference of habit, as well as from the quite considerable larval differences shown by the figure in Howard, Dyar and Knab's monograph, it seems probable that *A. barberi* is a distinct species from *A. plumbeus*. I have not however seen the American form. *A. plumbeus* is a common blood-sucker in wooded districts in this country, often biting in the daytime.

There evidently may be at least two broods of *A. plumbeus* in the year, as I found young larvae in a hole at the base of a beech tree in Cassiobury Park, Watford, on 21st August. In this case also the *Anopheles* larvae were associated with those of *O. geniculatus*.

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Genus TOXORHYNCHITES, Theo.

Toxorhynchites regius, Tennent.

Culex regius, Tennent, "Ceylon," p. 268 (1859).

Megarhinus immisericors, Theo., Mon. Cul. i, p. 225 (1901).

Megarhinus gilesii, Theo., Mon. Cul. i, p. 227 (1901).

Toxorhynchites immisericors, Theo. et auct. (*nec* Walk.).

The only description given by Tennent is "one with a formidable hooked proboscis," but this is sufficient to identify the species, since apart from the rare and inconspicuous *T. minimus* it is the only member of the genus which is known to occur in Ceylon. Theobald also states that he has seen Thwaites' specimens to which Tennent referred.

Toxorhynchites subulifer, Dol.

Megarhinus subulifer, Dol., Nat. Tijd. Ned. Ind., xiv, p. 382 (1857).

Megarhinus immisericors, Walk., Proc. Linn. Soc. London, iv, p. 91 (1860).

On re-examining Walker's types (from Celebes) I find they are distinct from the Oriental form which has been commonly known as *T. immisericors*, and therefore this name could not be used even if *C. regius* had not been published a year earlier. The chief points of difference are that in the Celebes species there are no lateral yellowish spots on the third and fifth abdominal tergites, while the fifth and sixth sternites are almost entirely purple, instead of being yellowish with a rather narrow purple stripe down the middle. There seems to be nothing in Doleschall's description of *M. subulifer* to distinguish it from *T. immisericors*, and as both were described from the Australasian region it will probably be safe to assume that they are the same. By so doing the confusion will be avoided which would result if Walker's name were now used in a different sense from that in which Theobald employed it. Doleschall's *M. amboinensis* is evidently a different species.

Genus AËDES, Mg.

After further study of both larvae and adults of a large number of species of the *Aëdes* group, I am now inclined to accept the view of Dyar and Knab that it will be most convenient to include almost all these forms within the single genus *Aëdes*, chiefly owing to the fact that there are so many intermediate forms, as regards the structure and length of the palpi and the shape of the scales, that any clear-cut division, even on unisexual characters, would seem to be impossible. The diversity of structure however is very much greater than it is in *Anopheles*, and it may therefore be justifiable to retain as subgenera some of the groups which have hitherto been regarded as genera. The number and exact limits of these subgenera cannot be decided upon until the mosquitos of this group are more thoroughly known; the following are rough definitions of the most important groups, but allowance must always be made for annectent species.

(1) Subgenus *Armigeres*, Theo.—Larval siphon without pecten; tuft minute or absent. Claspers of male genitalia usually with numerous articulated spines, very rarely only one. Male palpi always (so far as known) long, thin, without hair-tufts. Female claws always toothed; middle claws of male usually equal. Dark species with dark legs and flat scales on the head and scutellum.

Owing to the larval and male genital structure this is perhaps the most distinct of the subgenera of the *Aëdes* group, and were it not for the fact that I can find no definite character to separate the females from *Aëdes* I should prefer to retain it as a distinct genus.

(2) Subgenus *Stegomyia*, Theo.—Larva: antennae short, cylindrical, without microscopic spines, the tuft minute and never more than two-haired; frontal hairs always single; comb-scales in a single row. Male genitalia: claspers with a single terminal or subterminal articulated spine; side-pieces without apical lobes; unci usually more or less brush-like or pectinate. Male palpi usually long, thin, and without hair-tufts; quite short in two species (*annulirostris* and *thomsoni*). Female claws toothed or not. Female abdomen without distinct cerci, the eighth tergite prominent, but not the eighth sternite. Usually ornate species, frequently black and white, with conspicuous white rings on the legs; flat scales on head and scutellum.

(3) Subgenus *Ochlerotatus* (Arr.) Edw.—Larva: antennae longer than in *Stegomyia*, usually more or less curved and tapering, and covered with microscopic spines; tuft well-developed and nearly always many-haired; frontal hairs usually multiple; comb-scales nearly always in a triangular patch. Male genitalia very diverse, but the claspers with a single articulated spine, which may or not be terminal. Male antennae with the verticillate hairs more numerous dorsally and ventrally. Male palpi usually long, with the last two joints somewhat swollen, hairy and bent downwards; in a few species (*eatoni*, etc.) only about half as long as the proboscis. Female claws almost always toothed. Female abdomen with distinct projecting cerci, except in one group. Ornamentation very diverse.

The further classification of this subgenus is dealt with below.

(4) Subgenus *Aëdes*, Mg.—Larva, so far as known, like that of *Ochlerotatus*. Male genitalia extremely diverse, even in closely allied species; claspers without articulated spine, sometimes much reduced. Male palpi very short. Male antennae with the verticillate hairs less numerous and more evenly distributed than in *Ochlerotatus*. Female claws toothed. Female abdomen with distinct cerci. Dark species, not strikingly ornamental; head mainly covered with flat scales.

(5) Subgenus *Skusea*, Theo.—Larva not yet described. Male genitalia with five or six long processes which have apparently been derived from the basal lobes of the side-pieces, but in some cases have become nearly apical, resembling the somewhat similar structures of *Culex*. Male palpi long, hairy towards tip (*pembaensis*), long, thin and bare (*amesii*) or quite short (*simplex*). Female claws simple. Female abdomen pointed, as usual, and with distinct cerci.

Subgenus ARMIGERES, Theo.

The Oriental species of this subgenus are numerous and difficult to separate; the following is an attempt at a table of those in which the female palpi are short. A table of those (*Leicesteria* group) which have the female palpi more than half as long as the proboscis has been given previously.

1. Hind femora on the outer side dark apically	2
Hind femora on the outer side white to the tip	3
2. All tibiae about equal in length	*moultoni*, Edw.
Hind tibiae distinctly the shortest	*brevitibia*, Edw.

3. Abdominal tergites with apical yellowish bands .. .. *apicalis*, Theo.
   No such bands present; tergites black with white lateral spots 4
4. Thorax with distinct fine golden lines; white lateral spots on abdominal tergites extending dorsally towards apices of segments.. .. *aureolineatus*, Leic.
   Thorax usually dark above; abdomen differently marked 5
5. Abdominal sternites with black apical bands 6
   First six abdominal sternites entirely white 7
6. Mesonotum with distinct pale margin; dark bands on sternites 3–6 all about equal in width .. .. *obturbans*, Walk.
   Mesonotum without distinct pale margin; dark bands on sternites 3 and 4 much broader than those on 5 and 6 .. .. .. *durhami*, sp. n.
7. Seventh sternite black 8
   Seventh sternite white 11
8. Sides of mesonotum in male broadly, in female narrowly silvery .. .. *confusus*, Edw.
   Mesonotum in both sexes dark, without a distinct pale margin 9
9. Claspers of male genitalia with only four teeth .. .. *conjungens*, Edw.
   Claspers with 15–20 teeth 10
10. Basal lobes of side-pieces of male genitalia with three flattened appendages, with rounded tips .. .. *hybridus*, Edw.
    These appendages pointed and spine-like .. .. .. *kuchingensis*, Edw.
11. Mesonotum dark, without distinct pale margin .. .. *malayi*, Theo.
    Margins of mesonotum broadly silvery in male 12
12. Integument of thorax blackish (usually); male genitalia with a single weak spine on the basal lobes of the side-pieces .. .. *jugraensis*, Leic.
    Integument of thorax more reddish; basal lobes of side-pieces with three flattened plates .. .. *maiae*, sp. n.

Armigeres brevitibia, Edw.

This species was described from a single female from Kucking, Sarawak. Since the description appeared in print, additional specimens representing both sexes have been received from the same place; these were probably collected by Mr. J. Hewitt, and bear the following label: "bred from curious yellow long-lived larvae of about ⅜ in. long. Pupa lasted 7½ days. Aug. 1905."

The following structural characters of the male may be noted:—Palpi of the usual form, long, thin and upturned, considerably longer than the proboscis. Front and middle claws very unequal, the larger simple, the smaller in two specimens with a small tooth near the base, in a third simple. Genitalia: claspers long, thin, slightly swollen towards the tip, with a single short thick terminal spine; basal lobes of side-pieces hairy, but without differentiated spines or bristles; lobes of ninth sternite rather prominent and densely hairy; harpes and unci as in the other species. Under side of abdomen almost entirely dark.

The structure of the male claspers shows that this species is not at all closely related to any others in the subgenus; in fact, it is only included here, rather than in *Stegomyia*, owing to its general similarity in colouring to *A. obturbans*.

Armigeres aureolineatus, Leic. (fig. 1).

Originally described from the Malay Peninsula, this species has since been recorded from Sarawak and Ceylon. As already noted by Leicester, the markings of the abdomen are very similar to what is found in the *Leicesteria* group, although the male genitalia closely resemble those of the *Armigeres* group. A figure of these organs is given herewith (fig. 1).

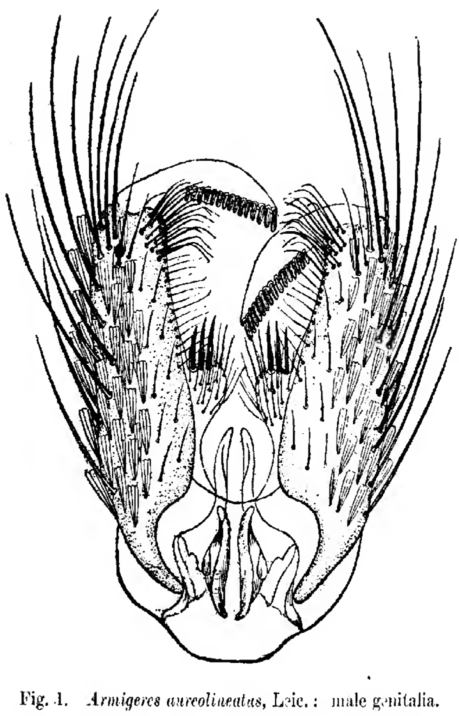

Fig. 1. *Armigeres aureolineatus*, Leic.: male genitalia.

Armigeres obturbans, Walk. (fig. 2).

Armigeres panalectoros, Giles, Gnats, Ed. ii, p. 386 (1904).

Both *A. obturbans* and its synonym *A. ventralis* were described from specimens from the Australasian region (Amboyna and Celebes), and therefore it seems open to question whether the common Indian and Chinese species is really correctly named. Walker's types in the British Museum however appear to agree with Indian specimens, and therefore the name may be retained for the present at least.

The species is subject to considerable variation in colour, particularly in the amount of pale scaling on the mesonotum. This is especially the case in a long series received from Hong Kong; some specimens from this locality show thoracic markings very much as figured by Giles for *A. panalectoros*, though less sharply defined, yet these

specimens agree in other respects, including genital structure, with *A. obturbans*. There can be little doubt therefore that *A. panalectoros* is only a form of *A. obturbans*, although the type male from which Giles described it is apparently lost.

The genitalia of *A. obturbans* are shown in fig. 2; as will be seen by comparison of this with Theobald's figure (Mon. Cul. iii, p. 138), the latter is very inaccurate.

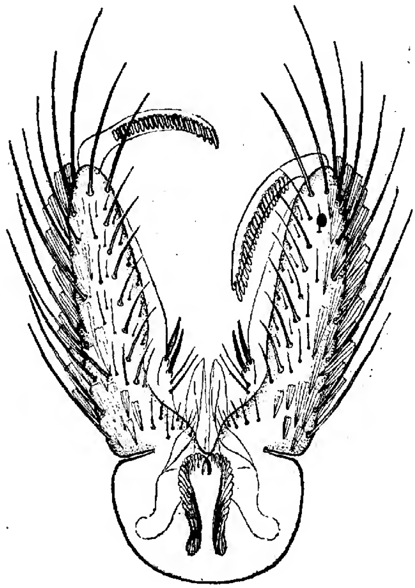

Fig. 2. *Armigeres obturbans*, Walk.; male genitalia.

Armigeres durhami, sp. nov.

Differs from *A. obturbans* by the characters indicated in the key, and also in the male genitalia, as follows:—Side-pieces rather shorter and stouter, their basal lobes with three flattened spiny bristles, much as in *A. kuchingensis*; claspers with a distinct swelling on the flexor surface a little beyond the middle.

FED. MALAY STATES: Bukit Kutu, 3,300 ft. Type male and one female bred from larvae in tub near bungalow, 11.v.1903; a second female caught at same place on same day, and a third 17.v.1903 (*Dr. G. F. Leicester*); also 3 ♀ from same place, 20.ii.1903 (*Dr. Durham*).

All specimens in the British Museum; those collected by Dr. Durham were named by Theobald *Desvoidya fusca*.

Armigeres malayi, Theo. (fig. 3).

Uranotaenia malayi, Theo., Mon. Cul. ii, p. 258 (1901).

Desvoidea fusca, Theo., Mon. Cul. iii, p. 135 (1903) (types only).

Theobald wrongly described the claws in the type of his *U. malayi* as simple; they are really toothed, and the specimen is quite recognisable as a small example of this species. The type male and female (so labelled by Theobald) of *D. fusca* are from Jugra, not Kuala Lumpur; the middle claws of the male are now missing, but it may be

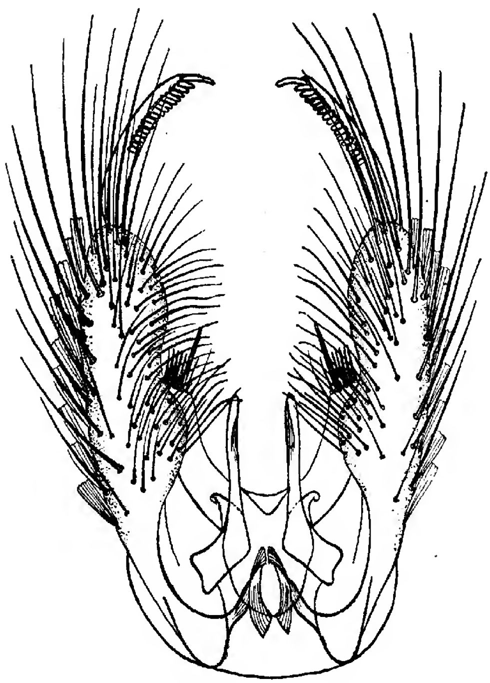

Fig. 3. *Armigeres malayi*, Theo.; male genitalia.

surmised that they were inaccurately figured. The specimens labelled by Dr. Durham as having been bred from the foul water in a stable catch-pit at Kuala Lumpur, which are the only ones Theobald mentions having examined, are *A. obturbans* and not *A. malayi*. The proper significance of the name *fusca* is therefore doubtful, but fortunately it need not be used, since *malayi* and *obturbans* are both of prior date.

The genitalia of this species are remarkably distinct, and are shown in fig. 3. From Taylor's description of the genitalia of *Neosquamomyia breinli* (Trans. Ent. Soc., 1914, p. 186) it is evident that this Papuan species is an *Armigeres* closely related to *A. malayi*.

Armigeres jugraensis, Leic.

Leicester's series consisted of two distinct species, which can readily be separated on male genital characters, although in other respects they are very similar. The specimens Leicester refers to as having been bred from " larvae found in a bamboo in Ampang jungle and in water collected in a fallen leaf in the jungle at Jugra " are however the same, and it is evident the name *jugraensis* must be restricted to them, as the other specimens were not definitely mentioned by Leicester.

In the true *A. jugraensis* the male genitalia are very similar to those of *A. obturbans*, but both the side-pieces and the harpes are shorter and stouter.

Armigeres maiae, sp. n. (fig. 4).

Differs from *A. jugraensis* as indicated in the key. Male genitalia, fig. 4.

FED. MALAY STATES: Kuala Lumpur district (*Dr. G. F. Leicester*); 1 ♂ labelled " 5th mile Gombak Rd., jungle, midday, 29.ii.1904 "; five ♀ from same place, 5.xii.1903 and 12.xii.1903; 1 ♂ (type) " jungle, Pahang Rd., 6 miles from Kuala Lumpur, 15.v.1904 "; and one other ♂ without exact data.

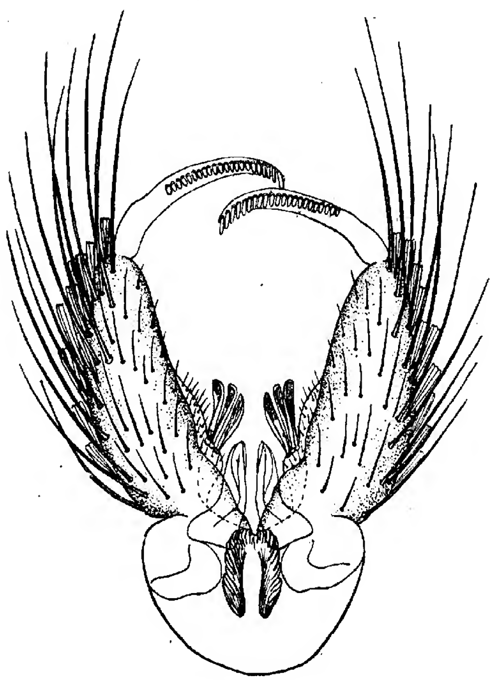

Fig. 4. *Armigeres maiae*, Edw., sp. n.; male genitalia.

This species is dedicated to my wife, to whom I am indebted for the four drawings of *Armigeres* genitalia now published.

Subgenus STEGOMYIA, Theo.

Stegomyia variegata, Dol. (fig. 5 *a*).

Culex variegatus, Doleschall, Nat. Tijd. Ned. Ind. xvii, p. 77 (1858).

Culex scutellaris, Walker, Proc. Linn. Soc., London, iii, p. 77 (1859).

Culex zonatipes, Walker, Proc. Linn. Soc., London, v, p. 229 (1861).

Stegomyia pseudoscutellaris, Theobald, Entomologist, xliii, p. 156 (1910).

A careful re-examination of the types of Walker's *C. zonatipes* and *C. scutellaris* shows that Theobald was mistaken in referring the former to *S. fasciata*, F., and in identifying the latter with the common Oriental species. Both are in fact unquestionably the same as the species Theobald subsequently described as *S. pseudoscutellaris*. The oldest of these names is *scutellaris*, and if this name were to be used to replace *pseudoscutellaris* endless confusion would be caused, but fortunately it seems practically certain that Doleschall's *C. variegatus*, described a year earlier than *scutellaris*, is also the same species, since he refers to the white line round the margin of the thorax. The name *Culex variegatus* had been used for two different species by Schrank and Blanchard before it was employed by Doleschall, but although neither of these species can be recognised, it is quite clear that neither of them belong to *Stegomyia*. As I have adopted the principle that a homonym can be revived when transferred to a fresh genus, provided it is not pre-occupied there also, I propose to use the name *S. variegata* (Dol.) for this species. This may not be strictly in accordance with the letter of the rules regulating zoological nomenclature, but it appears to me to be reasonable, and is moreover in line with the view taken by several leading entomologists.

S. variegata was recorded by Doleschall from Amboyna, and by Walker from Aru and New Guinea; specimens have been received at the British Museum from Fiji, Solomon Islands, New Caledonia and Christmas Island (S. of Java); Taylor has also recorded it from Samarai I. (Proc. Linn. Soc. N.S.W., xxxix, p. 456). Apart therefore from its occurrence at Christmas Island, where it was found in large numbers by Dr. C. W. Andrews, *S. variegata* seems to be a purely Australasian species; it is surprising that it does not appear to have been found on the continent of Australia. The genitalia (fig. 5 *a*), especially as regards their basal parts, are very different from those of *S. albopicta* (fig. 5 *b*).

Stegomyia albopicta, Skuse (fig. 5 *b*).

Culex albopictus, Skuse, Indian Mus. Notes, iii, no. 5, p. 20 (1895).

Stegomyia scutellaris, Theobald, Mon. Cul. i, p. 298 (1901).

Stegomyia scutellaris var. *samarensis*, Ludlow, Jl. N.Y. Ent. Soc. (1903).

Stegomyia samarensis, Ludlow, Psyche, xviii, p. 127 (1911).

The common Oriental species at present known as *S. scutellaris* must in future be called *S. albopicta*, since this appears to be the oldest available name. Apparently it is not absolutely confined to the Oriental region, as Taylor has recorded it from Papua (Trans. Ent. Soc., London, 1914, p. 189) and N. Australia (Proc. Linn. Soc. N.S.W., xxxix, p. 455). Except for a specimen from Honolulu, however, there are no Australasian specimens in the British Museum.

Stegomyia vittata, Bigot.

Culex vittatus, Bigot, Ann. Soc. Ent. France, (4) i, p. 227 (1861).

Stegomyia sugens, Theobald, Mon. Cul. i, p. 300 (1901), et auct. (*nec* Wied.).

Stegomyia brumpti, Neveu-Lemaire, Bull. Soc. Zool., France, xxx, p. 8 (1905).

Reedomyia albopunctata, Theobald, Mon. Cul. iv, p. 262 (1907).

There is unfortunately little or no doubt that Theobald wrongly identified Wiedemann's *C. sugens*, since that author does not mention the white rings on the femora and tibiae, which he certainly would have done if they had been present. It is impossible to say from the description what Wiedemann's *C. sugens* really was, but if the type could be found it might perhaps prove to be a rubbed *S. fasciata*.

Stegomyia fraseri, Edw. (fig. 5 *c*).

This species was described by me (Bull. Ent. Res. iii, p. 11, May 1912) from a single female from Uganda. Since then a good series including both sexes has been received by the Imperial Bureau of Entomology from Southern Nigeria; unfortunately the names of the locality and collector have been lost. These specimens agree perfectly with the type female. The male genitalia (shown in fig. 5c) resemble those of *S. apicoargentea*, except in having two instead of four bristles at the tips of the harpagones. A single female has also been taken by Mr. A. Bacot at Freetown, Sierra Leone.

Stegomyia thomsoni, Theo. (fig. 5 *d*).

A series of specimens bred from larvae taken in a hollow tree have been received from Pusa, Bengal (*F. M. Howlett*). The palpi are alike in both sexes, though rather longer and more distinctly jointed than in *Aëdes*. In view of the type of ornamentation of this species and also of the structure of the male genitalia (fig. 5 *d*), it seems best placed in *Stegomyia*, in spite of the short male palpi.

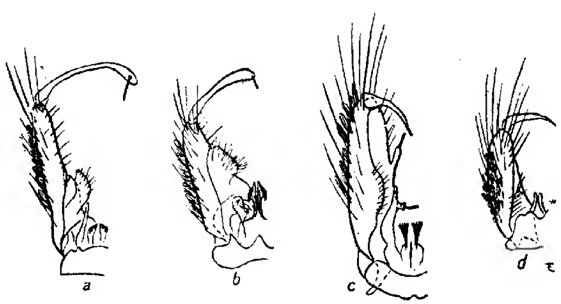

Fig. 5. Male genitalia of *Stegomyia*, ventral view:—(*a*) *S. variegata*, Dol.: (*b*) *S. albopicta*, Skuse; (*c*) *S. fraseri*, Edw.; (*d*) *S. thomsoni*, Theo.

I have also seen a male of *S. annulirostris*, Theo., taken by Major S. P. James in Ceylon; this species, which is evidently nearly allied to *S. thomsoni*, also has the palpi alike in the two sexes.

Subgenus OCHLEROTATUS (Arrib.), Edw.

Group *Finlaya*, Theo.

Finlaya, Theo., Mon. Cul. iii, p. 281 (1903).

Danielsia, Theo., Entom. xxxvii, p. 78 (1904).

Hulecoetomyia, Theo., Entom. xxxvii, p. 163 (1904).

Popea, Ludl., Can. Ent. xxxvii, p. 95 (1905).

Phagomyia, Theo., Gen. Ins. Cul. p. 21 (1905) (type, *P. gubernatoris*).

Lepidotomyia, Theo., Gen. Ins. Cul. p. 22 (1905) (type, *L. magna*).

Protomacleaya, Theo., Mon. Cul. iv, p. 253 (1907) (type, *P. triseriata*).

Pseudocarrollia, Theo., Rec. Ind. Mus. iv, p. 13 (1910).

This group can apparently be distinguished from *Stegomyia* and from *Ochlerotatus* (s. str.) by the characters of the female abdomen, the eighth sternite being very large, much larger than the tergite, and always exserted in repose; the cerci are always short. This character can be seen best in side view, the tip of the abdomen being laterally compressed. The male palpi are more or less intermediate between those of *Stegomyia* and *Ochlerotatus* (s. str.), most of the species having the last two joints slightly swollen and rather hairy; a few species (*trilineatus*, *japonicus*, etc.), which I propose now to include here on account of the structure of the female abdomen, have the male palpi almost exactly as in *Stegomyia*.

The male genitalia are of a fairly uniform type: the side-pieces without basal or apical lobes; the claspers simple, with a long terminal spine (rarely short); the harpagones well developed, with the terminal appendage long, curved and filamentous.

The scale characters, as usual, are extremely variable in different species, but most of the species are highly ornamented in one way or another. *O.* (*F.*) *poicilia* and its allies are at first sight very different from most of the other species, and have some peculiarities in the male genitalia, but they are approached in this respect by *O.* (*F.*) *pulchriventer*, while the structure of the female abdomen is normal.

The group is probably a natural one, since all the species, so far as known, are tree and plant breeders, but neither in larval nor adult characters is it possible to draw any sharp or satisfactory distinction from the other genera or subgenera of the *Aëdes* group. Some at least of the larvae have much more numerous branched hairs on the abdomen than is usual in *Ochlerotatus*.

The following species may be included in this group:—

Nearctic Region: *triseriatus*, Say. Palaearctic Region: *geniculatus*, Ol. (=*lateralis*, Mg.); *eatoni*, Edw.: *oreophilus*, Edw.; *pulchriventer*, Giles; *japonicus*, Theo.; *togoi*, Theo.; *macfarlanei*, Edw. Ethiopian Region: *longipalpis*, Grünb. (*wellmani*, Theo., and *fascipalpis*, Edw., may also belong here, but the structure of the female abdomen is more like that of *Stegomyia*). Oriental Region: *poicilia*, Theo.; *flavipennis*, Giles; *gubernatoris*, Giles; *melanopterus*, Giles; *lophoventralis*, Theo.; *trilineatus*, Theo.; *albotaeniatus*, Theo.; *niveus*, Ludl.; *pseudotaeniatus*, Giles; *greeni*, Theo.; *leucomeres*, Giles. Australasian Region: *notoscriptus*, Skuse; *australiensis*, Theo.; *kochi*, Dön.

Ochlerotatus (F.) geniculatus, Ol.

The early stages of this species have never been described, nor is there any certain record of its breeding habits, though Galli-Valerio and Rochaz de Jongh,* in recording that they have found larvae of *C. ornatus* in holes at the bases of trees, are very probably referring to *O. geniculatus*.

Early in April of the present year (1916) I found large numbers of larvae, in company with those of *Anopheles plumbeus*, in holes in beech trees at Burnham Beeches, Bucks. The larva is peculiar in several respects, having a greater resemblance to those of *Stegomyia* than to those of *Ochlerotatus*. The following description should make it easily recognisable :—

Antennae rather long, almost straight, slightly tapering towards the tip ; a single hair in place of a tuft about the middle ; no trace of minute spines over the surface. *Frontal hairs* : the usual four pairs present, two large and two smaller ; of the two larger pairs the anterior is two-branched, the posterior simple, almost in a line longitudinally with the anterior pair ; both these only about as long as the antennae ; the median pair small, four- or five-branched above the base, rather close to and almost in a line transversely with the anterior (two-branched) hair. Much further back, near the edge of the clypeus, is an additional single hair. *Abdomen* with numerous rather long four- or five-branched "stellate" hairs scattered over both the dorsal and ventral surfaces. *Comb* of eighth segment with about 12 teeth in a single, regular, slightly arched row ; the teeth apparently simple and produced into long sharp points. *Siphon* about three times as long as its base, regularly narrowed towards the apex ; pecten with 14–17 teeth, all close together, in a slightly diagonal row extending only about a quarter of the length of the siphon ; the first three or four teeth short, the rest much longer, each with one or two minute serrations at the base. Tuft of four simple hairs, in a line with the apex of the pecten, placed before the middle of the siphon. *Anal segment* with a chitinous saddle, the posterior edge of which is minutely spiny and carries a long three-branched hair. None of the hairs on the anal segment, or indeed anywhere on the body, are plumose. Upper pair of gills a little longer than the anal segment, and about half as long again as the lower.

Larvae of all sizes from newly hatched to full-grown, but mostly quite small, were found in the tree-holes on 4th April ; the first adult did not hatch out till 22nd April, but some of those which were only in the first or second stage on 4th April had produced adults by 4th May.

The adult is a very vicious and persistent biter.

Young larvae of a second brood were found in a hole at the base of a beech-tree in Cassiobury Park, Watford, on 21st August.

Ochlerotatus (F.) koreicus, sp. nov.

Head with a broad patch of narrow white scales on the vertex ; on each side of this a roundish area of broader black scales ; scales at the sides flat, white, including a black spot ; narrow white scales round the upper part of the eye-margins. Clypeus bare, black. First antennal joint with small flat white scales. Palpi and proboscis

* See Review of Applied Entomology, i, 1913, p. 40. I have been unable to consult the original paper.

entirely black-scaled; palpi of female a quarter as long as the proboscis, of male slightly shorter than the proboscis, the last two joints thin, somewhat upturned, and with very few hairs. *Thorax*: prothoracic lobes and area of mesonotum behind them with flat white scales. Mesonotum blackish, with blackish brown and golden-yellow scales, the latter arranged in definite, though not very sharply defined lines as follows: a continuous margin to the mesonotum; a median longitudinal line, forking just in front of the scutellum; a pair of short lines on the anterior half; a longer pair on the posterior half, bent outwards at the suture. Scutellum with whitish yellow scales in the middle of the median lobe, black ones on each side of these; these scales are narrow in the female, but much broader in the male: lateral lobes with a few black scales; spaces between the lobes bare. Pleurae with several patches of flat white scales. *Abdomen* blackish above, the segments with brilliant white, basal, lateral spots and small, dull white, median basal patches; on the eighth tergite the lateral spots meet in the middle. Venter black, the segments with brilliant white basal bands, which are somewhat narrowed in the middle. Eighth sternite of female with fairly numerous small flat whitish scales. *Male genitalia*: claspers strap-shaped, with a rather long terminal spine; side-pieces without apical or basal lobes; harpagones well developed, terminal spine long, curved, filiform. *Legs*: front pair blackish; femora with a creamy-white patch on the basal half in front, tip also creamy-white; rather narrow white rings at the bases of the first three tarsal joints. Mid legs similar, but the femora are whitish to the tip on the under side, the white tarsal rings are rather broader, and there is a very narrow one on the fourth joint. Hind femora white on their basal half, except for a narrow dorsal line; apical half with a broad blackish ring, narrower beneath; tips more broadly white than in the other legs; tarsal rings also broader, and there are a few white scales at the base of the fifth joint. Fore and mid claws toothed, in the male the larger claw with two teeth. *Wings* densely brown-scaled; scales of the lateral series rather broadly linear. Upper fork-cell with its base rather nearer the base of the wing than that of the lower. *Halteres* with bare yellowish stem; knob darker, with whitish scales on the outer side and darker ones on the inner.

KOREA: 1 ♂ 1 ♀ collected by *Dr. R. G. Mills* and received through *Dr. A. T. Stanton*; presented to the British Museum by the Imperial Bureau of Entomology.

O. (*F.*) *koreicus* is rather closely allied to *O.* (*F.*) *japonicus*, Theo., differing chiefly in the presence of white rings on the last two joints of the hind tarsi, in the less hairy male palpi, and the rather differently constructed harpes of the male genitalia.

Ochlerotatus (F.) fulgens, sp. nov.

Resembles *O.* (*F.*) *longipalpis*, Grünb. (= *Stegomyia pollinctor*, Graham), and is probably only a geographical form of it, but shows the following differences:— Palpi of female two-thirds as long as the proboscis, instead of only one-third. Space in front of scutellum almost covered with flat silvery scales, not largely bare. Median lobe of scutellum entirely covered with flat silvery scales, instead of having a patch of black ones in the middle. Harpes of male genitalia without the minute notch at the tip which occurs in *O. longipalpis*. Hind tibiae entirely blue-black, without any creamy patch at the base beneath. First joint of front tarsi entirely white beneath. First joint of mid tarsi entirely white on the posterior and ventral surfaces, but without

a complete white ring at the base; second joint white except at the tip. First joint of hind tarsi entirely blue-black, no trace of a white ring at the base.

A series received from ZANZIBAR (*Dr. W. M. Aders*), some bred from larvae found in a hole in a mango tree, 15.v.1915; also 1 ♀ from Karonga, NYASALAND, ii. 1912 (*Dr. A. G. Eldred*).

Type and other specimens presented to the British Museum by the Imperial Bureau of Entomology.

Ochlerotatus (F.) melanopterus, Giles.

Finlaya melanoptera, Giles, J. Trop. Med. vii, p. 367 (1904).

Popea palawanensis, Ludlow, Psyche, xxi, p. 31 (1914).

In my paper on synonymy of Oriental Culicidae (Bull. Ent. Res., 1913) I included *F. melanoptera* under *O. gubernatoris*, thinking that the tufts of long scales might not be normal, but since Dr. Ludlow has now described other specimens which have the same scale-tufts present, *melanoptera* is probably distinct from *gubernatoris*.

Ochlerotatus (F.) lophoventralis, Theo.

Pseudocarrollia lophoventralis, Theo., Rec. Ind. Mus. iv, p. 13 (1910).

In giving this also as a synonym of *O. gubernatoris*, I overlooked the fact that the scutellum is uniformly and densely clothed with flat white scales, which is not the case in the latter species; there are some other differences, *e.g.*, the white ring at the base of the front metatarsus of *O. lophoventralis*. Specimens have recently been received at the Museum from Pusa (*F. M. Howlett*).

Group *Diceromyia*, Theo.

Although in general ornamentation, as well as in the possession of peculiar scale-tufts on the side-pieces of the male genitalia, the species of this group resemble *O. poecilia* and its allies, they can hardly be included in the *Finlaya* group, since the eighth abdominal sternite of the female is not prominent, the terminal joint of the male palpi is minute and rounded, and the male genitalia are without harpagones. The only species which can at present be referred here are *O. furcifer*, Edw. (*Diceromyia africana*, Theo.) and the following new form.

Ochlerotatus (D.) adersi, sp. nov. (fig. 7 *a*).

Closely allied to *O. (D.) furcifer*, but differing as follows:—Proboscis without a definite pale ring, though there are numerous pale scales scattered over the basal half, these being more plentiful than the dark ones in the male. Abdominal tergites with sub-basal white lateral spots, which in some specimens are connected with basal median white bands, but without any scattered pale scales on the apical parts of the segments. There are more numerous yellowish-white scales on the front part of the mesonotum, but the scales on the scutellum are mostly black, instead of mostly white. Male genitalia similar to those figured by Theobald for *O. furcifer*, but the lateral scale-tuft has become apical through the enlargement of the inner aspect of the side-piece, and there is no apical hair-tuft such as is stated by Theobald to occur in *O. furcifer*; clasper as figured; harpes short; harpagones apparently absent.

ZANZIBAR: Mnazi Moja, 8.v.1916, bred from larvae in hole in almond tree, 2♂ 2♀ (*Dr. W. M. Aders*).

The males and one female presented to the British Museum by the Imperial Bureau of Entomology.

The "forking" of the clasper is due to the spine being placed far back, instead of being terminal as usual; it is an exaggeration of the structure found in *O. vexans*, Mg., and allied species, and may possibly indicate a connection between these species and *O. adersi*. The tuft of brownish yellow scales at the apex of the side-pieces is almost as long as the side-pieces themselves, and is very conspicuous.

Group *Ochlerotatus*, s. str.

After the exclusion of the *Finlaya* and *Diceromyia* groups, the remainder of the genus *Ochlerotatus* consists of a very heterogeneous mass of species, some more closely allied than others. It does not appear to be possible to draw any hard and fast lines within this group, since there are so many intermediate forms. The most natural classification of the group is probably one based on the structure of the male genitalia, but unfortunately there seem to be no tangible female characters which can be associated with those of the male. The following main groups may be distinguished:

(*a*) Group *Ochlerotatus*, in the most restricted sense. Side-pieces of genitalia with well developed apical and basal lobes; claspers with a long terminal spine; harpagones well developed, with a more or less flattened articulated terminal process. Species usually without any striking ornamentation, and with narrow scales on the scutellum and vertex. This group roughly corresponds to *Culicada* as used by Theobald, and includes the majority of the European, North American and Australian species. Transitional forms to the next group are to be found in *O. annuliferus* (Ludlow) and *O. fryeri* (Theo.), in which the apical lobes of the side-pieces are absent, the harpagones small and with their terminal process short and spine-like.

(*b*) Group *Ecculex*. Side-pieces without apical lobes, but the basal lobes well developed and hairy; claspers with the terminal spine inserted at some distance before the tip, giving a forked appearance; harpagones absent. In general aspect the species resemble those of the preceding group. The following species may be included:—*O. vexans* (Mg.), *O. hirsutus* (Theo.), *O. cumminsi* (Theo.), *O. dentatus* (Theo.), *O. quasiunivittatus* (Theo.), *O. caliginosus* (Grah.).

(*c*) Group *Aëdimorphus*. Side-pieces without either apical or basal lobes; claspers usually highly specialised, though often resembling those of the preceding group; harpagones absent. This group, though on the whole a natural one, seems to merge on the one hand into the *Ecculex* group and on the other into *Stegomyia*. It includes most of the species placed by Theobald in *Aëdimorphus* and *Reedomyia*, with a few other African and Oriental species.

Ochlerotatus annulipes, Mg.

This species occurs abundantly on Wood Walton Fen, Huntingdonshire, where it is a severe daytime biter, like its ally *O. maculatus* (Mg.). A number of specimens from this locality were presented to the British Museum in 1913 by the Hon. N. C. Rothschild, by whose kind permission I visited the fen in April 1914 with the object of searching for the larvae of this species and *Aëdes cinereus*, another species which Mr. Rothschild had taken in numbers there. Although not successful in obtaining larvae of the *Aëdes*, I found large numbers of *O. annulipes* larvae in shallow temporary

pools amongst the reeds. A close examination of these larvae has failed to reveal any differences whatever between them and *O. maculatus*; a result which is not a little surprising, in view of the fact that when there are conspicuous differences in the male genitalia, as there are in these two species, they are usually associated with marked differences in the larvae.

Ochlerotatus nemorosus, Mg. (fig. 6 *a*).

This species is very abundant on Harrow Weald Common, Middlesex. The larvae appear in the temporary pools in the hollows about Christmas, and become full-grown about the middle of March, the first adults appearing towards the end of that month. Normally, as in other related species, there is only one brood in the year, and attempts to hatch out larvae in the early autumn by placing dry leaves from the hollows in water have failed. Last year (1915), however, the weather conditions were abnormal; an early spell of dry weather caused the pools to dry up completely by the middle of April, about a month earlier than usual; this was followed later on by a very wet summer, and the hollows were filled up again and remained full for several months, whereas in normal years they are dry from about the middle of May till about the end of November. Under these circumstances a plentiful second brood of *O. nemorosus* was produced in July, and the specimens of this brood were, if anything, even more vicious in their attacks than those of the first brood.

Fig. 6. Scales from the comb of the eighth abdominal segment of *Ochlerotatus* larvae:—(*a*) *O. nemorosus*, Mg.; (*b*) *O. dorsalis*, Mg.: (*c*) *O. salinus*, Fic.

While watching one day a number of these second-brood insects feeding on my hand and ankle, I suddenly noticed that one of them was apparently a male. I at once secured it, and kept a look out for others. In about ten minutes I had taken three in the act of sucking, while a fourth had escaped. Probably more could have been secured if time had allowed, but unfortunately I had no other opportunity of visiting the locality until the mosquito season was over. A close examination later of the three specimens taken showed that none of them were normal males, but all three had one or more female characters on one or both sides of the body. It seems not improbable, therefore, that other male specimens of various mosquitos which have occasionally been recorded as biting were really partly hermaphrodite. As very few cases of hermaphrodite mosquitos have been recorded, it may be of interest to describe these examples:—

Specimen A.—Left antenna as in male, normal. Right antenna with the basal joint a little smaller than in a male; following 11 joints shorter, stouter and more hairy than in a female, but more like this sex; last two joints rather elongate, but together scarcely longer than the penultimate joint of the left antenna. Left palp about half as long as the proboscis, its tip thickened, distorted, and hairy. Right palp as in female, normal. Hypopharynx normal, as in female. Both mandibles absent.

Left maxilla normal; right present, but abnormally slender. Left front claws male, right female; left middle claws female, right male. Genitalia male, perfectly normal.

Specimen B.—Left antenna with basal joint as in female; next 10 joints very short and with long hairs, but not truly male in character; last three joints more elongate and female in appearance. Right antenna similar, but much less hairy, and the last 7 joints almost typically female. Left palp about a third as long as the proboscis, the terminal joint much larger than in the female, oval, but not very hairy. Right palp similar, but a little shorter. Hypopharynx, mandibles and maxillae normal (female). Inner left front claw longer than outer, but without a tooth; right front claws female. Inner left middle claw longer than outer, but shorter and straighter than in male; right middle claws normal (female). Genitalia female, quite normal.

Specimen C.—Left antenna similar to that of specimen B, but the ante-penultimate joint is shorter. Right antenna similar to the left. Left palp similar to that of specimen B. Right palp a little longer and more hairy than the left. Hypopharynx, mandibles and maxillae normal (female). Front claws female. Inner claws on mid legs a little longer than the outer, that on the left leg without a tooth. Genitalia normal, female.

Ochlerotatus dorsalis, Mg., and **O. salinus,** Fic. (fig. 6 *a*, *b*).

So far as I am aware, the larvae of these two species have never been described. They are usually found together, the larvae feeding in brackish or salt water. I found larvae at Beckton Marsh, London, E., in April 1914, and at Tal-y-bont, Merioneth, in July 1914. In the latter case the young larvae were in a rather foul puddle of brackish water immediately behind a shingle bank; the larval and pupal stages occupied about a fortnight, so that there are evidently several generations in the year.

The larvae of both these species rather closely resemble those of *O. nemorosus*, but are easily distinguishable under a microscope. The following characters will serve to distinguish the three species.

O. nemorosus: Antennae not conspicuously lighter at the base. About 12–16 scales in the comb of the eighth segment; scales slightly fringed at the base and produced into very long sharp points (fig. 6 *a*). Teeth of pecten with two or three serrations near the base, of which the apical one is much the largest. Gills a little longer than the anal segment, sharply pointed.

O. dorsalis: Antennae conspicuously pale at the base. About 24 scales in the comb of the eighth segment; scales pointed, but shorter than those of *O. nemorosus* and heavily fringed (fig. 6 *b*). Teeth of pecten with two or three serrations near the base, of which the apical one is considerably the largest. Gills scarcely half as long as the anal segment, bluntly pointed.

O. salinus: Antennae conspicuously pale at the base. About 24 scales in the comb of the eighth segment; scales blunt-ended, heavily fringed (fig. 6 *c*). Teeth of pecten with three or four serrations near the base, of which the apical one is very little larger than the others. Gills very short, almost globular, the dorsal pair a little longer than broad.

It is very interesting to note that *O. salinus*, which in the adult is so much like *O. nemorosus*, differs more in the larval stage from *O. nemorosus* than *O. dorsalis* does.

Mediterranean specimens of both *O. dorsalis* and *O. salinus* are usually much lighter in colour than British examples, but there is no difference in the genitalia. I cannot agree with Gough that Linnaeus' *Culex aegypti* is *O. dorsalis*; the description seems to me to indicate quite clearly some species of *Stegomyia*.

Ochlerotatus fryeri, Theo. (fig. 7 *b*).

Culicelsa fryeri, Theo., Trans. Linn. Soc. xv., p. 84 (1912).

I have previously given this as a synonym of *O. nigeriensis* (Theo.), but close examination of the type with fresh material received from Mombasa, British E. Africa (*Dr. J. O. Shircore*), and Magogoni swamp, near Witu, British E. Africa (*S. A. Neave*) shows that it is really distinct. The chief difference is to be found in the male genitalia, the claspers being quite unlike those of *O. nigeriensis*, *O. sudanensis* or *O. durbanensis*; a figure is given herewith. The side-pieces are very stout, their basal lobes being developed into small harpagones which have a short straight terminal spine. Apart from this the species, though rather smaller than *O. nigeriensis*, is of a distinctly stouter build; the sixth tergite of the female abdomen has a narrow pale apical line instead of an apical pair of pale spots, and the basal white bands on the sixth and seventh tergites tend to spread out backwards in the middle line, which is not the case in *O. nigeriensis*. Both species occur in East Africa, *O. nigeriensis* having been received from Zanzibar (*Dr. W. M. Aders*) and Nyasaland (*S. A. Neave*, *Dr. R. Burn*).

Ochlerotatus vexans, Mg.

Culex vexans, Meigen, Syst. Beschr. vi, p. 241 (1830).

Culex articulatus, Rond., Bull. Soc. Ent. It. iv, p. 30 (1872).

Culex sylvestris, Theo., Mon. Cul. i, p. 406 (1901).

Culex vagans, Theo., Mon. Cul. i, p. 411 (1901).

Culicada nipponii, Theo., Mon. Cul. iv, p. 337 (1907).

Culicada minuta, Theo., Mon. Cul. iv, p. 338 (1907).

Culex stenoetrus, Theo., Mon. Cul. iv, p. 395 (1907).

Culicada eruthrosops, Theo., Mon. Cul. v, p. 299 (1910).

Culex pseudostenoetrus, Theo., Mon. Cul. v, p. 343 (1910).

? *Culex nocturnus*, Theo., Mon. Cul. iii, p. 159 (1903).

Culex hirsutum, Ludlow, Psyche, xviii, p. 126 (1911).

I have compared mounts of the genitalia of specimens from Canada, England, India, and Ceylon, and find them absolutely identical. Ficalbi's figure, which has been copied by Theobald and Kertesz, is rather inaccurate, the structure being better represented in the figure given by Howard, Dyar and Knab (Plate 34, fig. 225); even this, however, is not quite correct, the shape of the clasper agreeing with the African *O. dentatus* as figured by me (Bull. Ent. Res. v, p. 277, 1915). *O. dentatus*, however, must be distinct from *O. vexans*, as the tarsi are entirely dark, and there are slight differences in the basal parts of the genitalia. I have not seen a male of *O. nocturnus*, but have included it with some doubt in the synonymy, as the females appear to agree closely with the Oriental form of this species.

It is extremely remarkable that a non-domestic mosquito should have such a wide range as *O. vexans* apparently has, extending over North America, Europe, China,

Japan, India, Ceylon, Philippines, Borneo and perhaps Fiji, male or female specimens from all these countries being in the British Museum collection. Since I can detect no structural differences whatever, I prefer to regard all these specimens as representing a single species, which in different parts of its range is subject to some local variation in size and colour. I can distinguish the three following varieties :—

(1) *vexans*, Mg. (=*articulatus* Rond., =*sylvestris*, Theo.). Pale abdominal bands contracted sharply in the middle, or even sometimes divided into a pair of pale spots. Europe and North America.

(2) *stenoetrus*, Theo. (=*minuta*, Theo., etc.). Pale abdominal bands very little or even not at all contracted in the middle. Size rather smaller on the average than *O. vexans vexans*. Oriental Region.

(3) *nipponii*, Theo. (=*vagans*, Theo. *nec* Wied.). Size as in *O. vexans vexans*, and the basal pale abdominal bands contracted in the same way, but the abdomen has in addition a more or less interrupted pale median dorsal line, and the sixth tergite has a conspicuous apical pale triangle. China and Japan. (This can hardly be Wiedemann's *vagans*, since he does not mention white rings on the tarsi.)

Ochlerotatus minutus, Theo. (fig. 7 *c*).

A single male has been received from Mlanje, Nyasaland (*S. A. Neave*), which I think must belong to the type form of *minutus*, with flat scales over the top of the head ; the specimen is too much rubbed to name with absolute certainty, but if it is correctly associated with the type female from Mashonaland, *O. minutus* must be quite a distinct species from *O. tarsalis* (see below). The male claspers are very peculiar, and are shown in fig. 7 *c* ; the only African species which has rather similar claspers is *O. domesticus*, Theo. *O. minutus* apparently occurs also in West Africa, as females with flat scales on the vertex have been received fron Sierra Leone (*Dr. H. E. Arbuckle*) and the Gold Coast (Obuasi, *Dr. W. M. Graham*, and Bjere, *Dr. A. Ingram*). The dark bands on the under side of the abdomen are much broader in this than in the allied forms.

Figures of the male claspers of *O. tarsalis*, *O. irritans* and *O. nigricephalus* are given for comparison. It may be mentioned that the claspers of *O. argenteopunctatus* and *O. punctothoracis* are very similar to those of *O. tarsalis*, and quite unlike *O. minutus* and *O. domesticus*.

Ochlerotatus tarsalis, Newst. (fig. 7 *d*).

Duttonia tarsalis, Newstead, Ann. Trop. Med. i, p. 18 (1907).

Duttonia africana, Newstead, Ann. Trop. Med. i, p. 20 (1907).

Reedomyia biannulata, Theo., Mon. Cul. iv, p. 263 (1907).

Reedomyia neobiannulata, Theo., Mon. Cul. v, p. 255 (1910).

Reedomyia bipunctata, Theo., Mon. Cul. v, p. 256 (1910).

Neopecomyia uniannulata, Theo., Mon. Cul. v, p. 261 (1910).

Most of the above names were previously given by me (Bull. Ent. Res. iii, p. 21) as synonyms of *O. minutus*, but as stated above I now consider *O. minutus* to be a distinct species, consequently the commoner form must now be known as *O. tarsalis*. I do not think there can be much doubt in regard to the synonymy now given. To

the synonyms given previously I have added *Duttonia africana*, since specimens received from Sierra Leone (*A. Bacot*) have convinced me that it is nothing more than a variety of *O. tarsalis*. On the other hand, since no males have been received from the Seychelles Is., the name *Reedomyia seychellensis* is omitted; and in addition *Stenoscutus africanus* proves on more careful examination to be a distinct species.

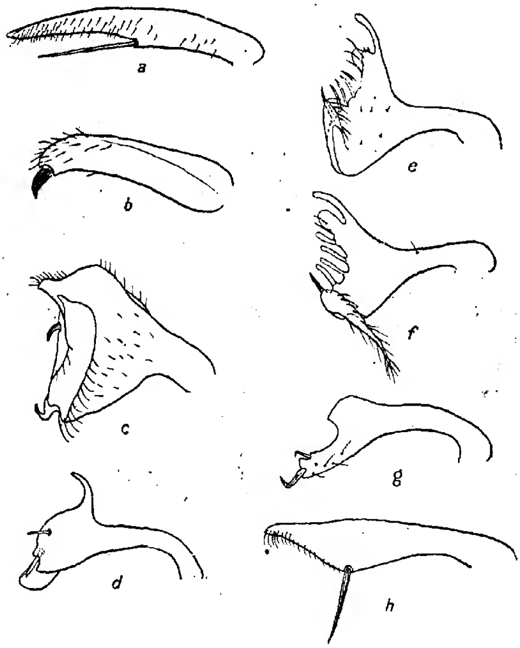

Fig. 7. Male genital claspers of *Ochlerotatus*:—(*a*) *O. adersi*, Edw., sp. n.; (*b*) *O. fryeri*, Theo.; (*c*) *O. minutus*, Theo.; (*d*) *O. tarsalis*, Newst.; (*e*) *O. abnormalis*, Theo.; (*f*) *O. alboventralis*, Theo.; (*g*) *O. irritans*, Theo.; (*h*) *O. nigricephalus*, Theo.

Ochlerotatus abnormalis, Theo. (fig. 7 *e*).

Bathosomyia abnormalis, Theo., Mon. Cul. v, p. 268 (1910).

Stenoscutus africanus, Theo., Mon. Cul. v, p. 263 (1910).

Ochlerotatus minutus var. *stenoscutus*, Edw., Bull. Ent. Res. iii, p. 22 (1912).

I have remounted Theobald's slide of the genitalia of the type male, and give herewith a figure of the clasper. I think there can be no doubt that *S. africanus* is the female of this species. The lateral abdominal spots are dull creamy-white, not brilliant silvery-white as they are in *O. minutus* and *O. tarsalis*.

Ochlerotatus alboventralis, Theo. (fig. 7 *f*).

A good series of both sexes of this species have been received from Kabinda, Katanga (*Dr. J. Schwetz*), and also a single male from Kitui, British East Africa (*T. J. Anderson*). It rather closely resembles *O. abnormalis* and is possibly a geographical form of it; it can be distinguished by the presence of numerous white scales on the mesonotum. There are also some differences in the male genital claspers which are probably of specific importance.

Subgenus Aëdes, Mg.

A considerable number of Oriental species must be included with *A. cinereus* in this subgenus, the majority of them being so extremely similar in appearance that it is difficult to find any characters, apart from those of the genitalia, to separate them. When however the genitalia are examined, their structure is so extraordinarily diverse that it is very difficult even to homologise the different parts. Thus the nine species *ceylonicus, virilis, singularis, uncus, leicesteri, pseudomediofasciatus, yerburyi, varietas* and *fragilis,* whose genitalia are shown in fig. 8 *a–i*, apparently only differ externally in the width and position of some of the wing scales and the shape of the pale abdominal markings, while several appear to be absolutely indistinguishable apart from genital characters. All these species have a reddish-tinged thorax; two other species, *butleri* and *panayensis* (genitalia, fig 8 *j* and *k*) differ chiefly in having a blackish thorax. These eleven species, together with *A. cinereus*, are the only ones of which I have seen males, but doubtless many others occur in the Oriental region. Theobald's *pseudodiurna* is probably distinct from any of those figured here.

Aëdes cinereus, Mg.

Aëdes cinereus, Mg., Syst. Beschr. i, p. 13 (1818).

Aëdes fuscus, O.S., Bull. U.S. Geol. Surv. iii, p. 191 (1877).

There is, I think, no doubt that the European and North American species of *Aëdes* are one and the same. So far as I have seen, there is very little variation among British examples, except that the thorax of the male is very often quite black instead of reddish. The abdomen in these specimens is always dark brown above, with a pale lateral longitudinal stripe, the edge of which forms a straight line. Some of the Canadian specimens in the British Museum are coloured in exactly the same way; others however have pale basal bands on the abdominal segments, and in these the upper margin of the lateral pale stripe is indented towards the apex of each segment. Both these forms have the male genitalia absolutely identical in structure with those of British examples, and it therefore seems justifiable to conclude that we are dealing with only one species, which is more variable in North America than it is in Europe..

Aëdes ceylonicus, sp. nov. (fig. 8 *a*).

Genitalia: Ninth tergite with a pair of terminal projections as in *A. singularis,* but the clasper is minute. External characters as in *A. varietas,* Leic.

One male from Colombo, Ceylon (*K. McGahey*).

Aëdes yerburyi, sp. nov. (fig. 8 *g*).

Genitalia: Dorsal side with a pair of enormous lobes, which may be developed either from the ninth tergite or from the side-piece, I am not sure which. Claspers small. A long, thick, sinuous rod possibly represents the harpes. External characters as in *A. varietas*, Leic.

One male from Kitli station, Ceylon, 29.xi.1891 (*Lt.-Col. Yerbury*).

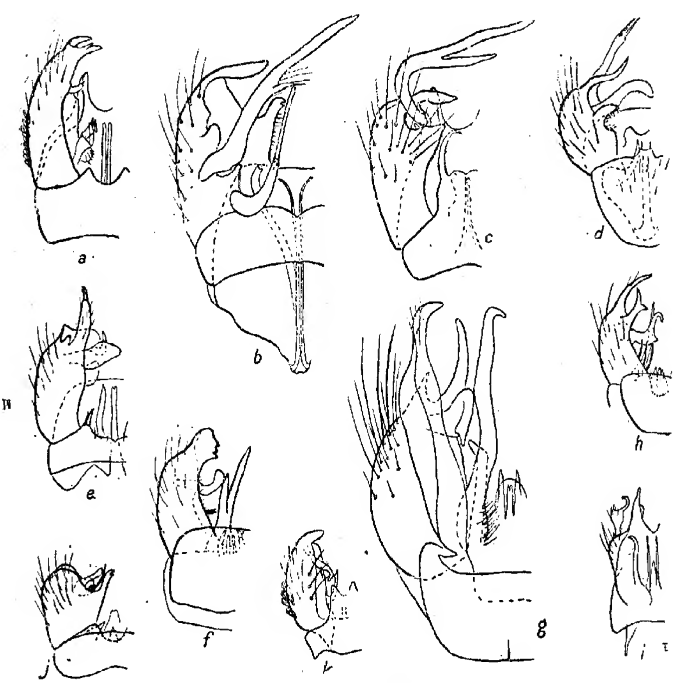

Fig. 8. Male genitalia of Oriental species of *Aëdes*, all to the same scale:—(*a*) *A. ceylonicus*, Edw., sp. n., ventral view; (*b*) *A. virilis*, Leic., ventral view; (*c*) *A. singularis*, Leic., ventral view; (*d*) *A. uncus*, Theo., dorsal view; (*e*) *A. leicesteri*, Edw., sp. n., ventral view; (*f*) *A. pseudomediofasciatus*, Theo., dorsal view; (*g*) *A. yerburyi*, Edw., sp. n., dorsal view; (*h*) *A. varietas*, Leic., dorsal view; (*i*) *A. fragilis*, Leic., ventral view; (*j*) *A. butleri*, Theo., dorsal view; (*k*) *A. panayensis*, Ludl., ventral view.

Aëdes leicesteri, sp. nov. (fig. 8 *e*).

Genitalia: Ninth tergite with its posterior edge simple. Ninth sternite with a pair of projections, each bearing two spines. External characters as in *A. varietas*.

One male from Kuala Lumpur, Federated Malay States, taken by stream in Ampang Jungle, 21.v.1904 (*Dr. G. F. Leicester*).

Aëdes uncus, Theo. (fig. 8 *d*).

This species was described by Theobald from a single female from Selangor; it is impossible to say what male really belongs to it, but for convenience I have associated with it two males from Dr. Leicester's collection.

Aëdes singularis, Leic. (fig. 8 *c*).

A male of this species, agreeing well with Leicester's type from Kuala Lumpur, has been received from Kuching, Sarawak (*J. C. Moulton*). This is the only species of this group which I have seen from more than one country, but the fact that one at least is not confined to a small area would seem to indicate that we are here dealing with distinct species and not with mere local races.

Subgenus Skusea, Theo.

Skusea pembaensis, Theo.

Ochlerotatus pembaensis, Edw., Bull. Ent. Res. v, p. 277 (1915).

I have previously (Bull. Ent. Res. iv, p. 229, 1913) mentioned *S. funerea* as the type species of *Skusea*, but in doing so had overlooked the fact that Blanchard had already designated *S. pembaensis* as the type. The male of *funerea* is apparently still unknown, but it is probable that it will prove to be allied to *S. pembaensis* in respect of the palpi and genitalia.

Skusea amesii, Ludlow.

Stegomyia amesii, Ludlow, J. N. Y. Ent. Soc. xi, p. 139 (1903).

Stegomyia fusca, Leic., Cul. of Malaya, p. 92 (1908).

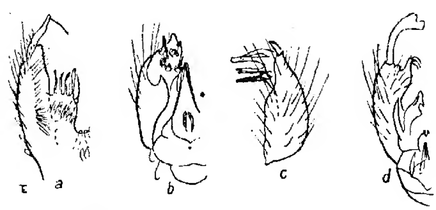

Fig. 9. Male genitalia of *Skusea*:—(*a*) *S. amesii*, Ludl.; (*b*) *S. simplex*, Theo., ventral view; (*c*) *S. simplex*, Theo., side view of side-piece; (*d*) *S. longirostris*, Leic.

This species is included here for want of a better place; it resembles *Stegomyia* except for the almost uniform dark colouring, but the genitalia are very remarkable in having two basal lobes to the side-pieces; one, dorsal, forming the harpagone; the other, ventral, bearing five long processes. These processes are perhaps homologous with those of *pembaensis* and *simplex*; if this is so, their apical position in these two species is only secondary. The genitalia of *S. amesii* are shown in fig. 9 *a*. I believe the synonymy given above is correct, though the only male specimens I have seen are from the Malay Peninsula. In any case, when *Skusea* and *Stegomyia* are regarded as subgenera of *Aëdes*, Leicester's name is preoccupied by Osten-Sacken's *Aëdes fuscus*.

Skusea simplex, Theo.

Ficalbia simplex, Theo., Mon. Cul. iii, p. 297 (1903).

Aëdes simplex, Edw., Bull. Ent. Res. iv, p. 238 (1913).

The simple claws of the female and the long processes of the male genitalia would seem to justify the association of this species with *pembaensis*, although the claspers are much reduced, and, as in *Aëdes*, have no distinct spine. I have shown the structure of the genitalia as well as I could make it out in the single specimen (fig. 9 *b* and *c*).

Skusea longirostris, Leic. (fig. 9 *d*).

Ficalbia longirostris, Leic., Cul. of Malaya, p. 228 (1908).

Although not at all closely related to the species mentioned above, this species would seem to be better placed here than in *Aëdes*, owing to the simple female claws. As in most species of *Aëdes*, the male genital clasper seems to be without any trace of an articulated spine.

Genus Taeniorhynchus, Arr.

Taeniorhynchus nigrosignatus, nom. nov.

Taeniorhynchus conopas, Theo., Mon. Cul. i, p. 202 (1901) (nec *Culex conopas*, Frauenf.).

? *Pseudotaeniorhynchus conopas* var. *giblini*, Taylor, Trans. Ent. Soc., 1914, p. 198.

It is quite obvious from Frauenfeld's description of *C. conopas* that the insect he had was not one of the yellow species of *Taeniorhynchus* with black-ringed legs; what it was is impossible to say without seeing the type, since the description is quite inadequate, but it may possibly have been *Mansonioides uniformis*.

So far as can be judged from Taylor's description of *T. giblini*, this form shows sufficient differences to be distinguished specifically from Oriental specimens, and as there is no other name available for these latter the above new designation is proposed.

Genus Culex, L.

Since the different groups of *Aëdes* are now regarded as only subgenera, it is desirable that the name *Culex* should also be employed in a rather wider sense than that in which I have used it. The structural differences between *Culex*, *Culiciomyia*, *Lophoceratomyia* and *Micraëdes* are of much less moment than those between the various groups of *Aëdes*, and it is doubtful whether some of the former names should be retained even in a subgeneric sense. *Culiciomyia* and *Lophoceratomyia* are fairly distinct, and so are the large carnivorous forms *Lutzia* and *Jamesia*, but *Cyathomyia* might well be regarded as merely somewhat aberrant species of *Culex*. An undescribed species from Japan affords a good connecting link between *Cy. brevipalpis*, Giles, and typical *Culex*, and among the American species there are apparently some with male palpi intermediate in length between those of *Cy. brevipalpis* and *Micraëdes inconspicuosus*.

Subgenus Culex, L.

Culex tritaeniorhynchus, Giles.

This species has so far only been recorded from the Oriental and Eastern Palaearctic regions, but by a strange coincidence I recently received for examination on the same day a male from Zanzibar (*Dr. W. M. Aders*) and a number of females from Accra,

Gold Coast (*Dr. J. W. Scott Macfie*). Subsequent re-examination of the British Museum series of *C. thalassius* revealed one female of *C. tritaeniorhynchus* from Weshiang, Gold Coast (*Dr. H. F. Hamilton*), and a further series representing both sexes has since been received from Accra.

I have previously stated (Bull. Ent. Res. iv, p. 233) some of the characters by which *C. tritaeniorhynchus* may be distinguished from its two nearest allies, *C. sitiens* and *C. vishnui*, but in doing so I overlooked some of the most important, which are as follows :—On the under side of the proboscis of the female the pale ring is much extended basally, though its edges are ill-defined ; often the basal three-fifths of the proboscis is almost all pale beneath, and frequently near the base the pale scales extend on to the side or even on to the dorsal surface, in which case the proboscis may appear to have two pale rings. The tip of the male palpi is dark (in *C. vishnui* it is narrowly and in *C. sitiens* rather broadly pale). The long joint of the male palpi has one narrow pale ring, and one broad one (in the two other species the two pale rings are equally broad). Finally the wing scales of *C. tritaeniorhynchus* are longer and narrower than in the other two. The African specimens are rather darker than those from the Oriental region, and the basal extension of the pale ring on the under side of the proboscis is not always observable.

Culex thalassius, Theo.

This seems to be the representative of *C. sitiens* in the Ethiopian region south and west of Somaliland. The genitalia of the two are practically identical, and *C. thalassius* seems only to differ in the absence of scattered pale scales on the femora and tibae. *C. accraensis* and *C. neotaeniorhynchus* are, as I have already stated, synonyms of *C. thalassius*, but I find I was wrong in including *C. bifoliata* here also ; after carefully mounting and examining the genitalia of the two males on which Theobald based his description of *C. bifoliata*, I find that one was really *C. duttoni* and the other *C. invidiosus*.

Culex vishnui, Theo.

Culex perplexus, Leic., Cul. of Malaya, p. 150 (1908).

The type male and female of Leicester's *C. perplexus* have recently been presented to the British Museum by Dr. A. T. Stanton, from the Kuala Lumpur collection. The male genitalia are identical with those of *C. vishnui*, and *C. perplexus* may therefore be regarded as a variety of this species in which the thorax has more definite markings than usual. *C. vishnui* is subject to a good deal of variation.

Culex whitmorei, Giles.

Culex loricatus, Leic., Cul. of Malaya, p. 151 (1908).

The type of *C. loricatus* has also been presented by Dr. Stanton, and proves to be identical with *C. whitmorei*.

Culex fuscocephalus, Theo.

Culex uniformis, Leic., Cul. of Malaya, p. 159 (1908).

The above synonymy is apparent from the description, although I have not seen any of Leicester's specimens. The species seems to be widely distributed in the Oriental region, specimens having been received from Dr. Stanton from Bangkok, Kuala Lumpur, Batavia and Makasser.

Culex rima, Theo.

I endeavoured to distinguish this from *C. insignis*, Carter, by the absence of distinct apical white bands on the abdominal segments. However the type of *C. rima* has traces of these bands, and there is no doubt that they are normally present in this species, though occasional specimens are found without them. *C. insignis* may therefore be synonymous with *C. rima*, though there are slight differences in the male genitalia between specimens from West Africa and from Uganda, from which latter country *C. insignis* was described. I do not consider that these differences are of greater than varietal significance.

Subgenus Lophoceratomyia, Theo.

This group can be distinguished from *Culex* proper by the peculiar hair- or scale-tufts on the male antennae, and also by the scanty scaling of the wings in both sexes, due to the practical absence of the lateral series of scales except towards the tip of the wing. In the least specialised species, such as *L. hewitti* and *L. minutissima*, only the ninth joint of the male antennae bears a long pencil of matted hairs on the inner side, pointing obliquely downwards; the more typical species however have variously formed scale-tufts on the sixth, seventh, eighth and tenth joints as well. The larvae of three species (*L. uniformis, L. mammilifer* and *L. minor*) have been received at the British Museum; there seems to be nothing to distinguish them generically from *Culex*. The siphon is long and thin and the comb on the eighth segment is in the form of a triangular patch.

The group has hitherto been recorded only from the Oriental region, but, as indicated below, two Australian species described by Theobald under *Culex* really belong here, and it is possible that some of Taylor's recently described species do also. The following is an attempt to tabulate the Oriental species. The table necessarily applies chiefly to the males, as it is often almost impossible even by comparison of specimens to determine females alone.

1. Basal joint of male antennae simple; species often reddish-tinged .. 2
   Basal joint of male antennae with a blunt prominence on the inner side; blackish species 7
2. Sixth to eighth joints of male antennae without scale-tufts; abdomen banded *minutissima* (Theo.).
   Sixth to eighth joints of male antennae with scale-tufts 3
3. Scales on sixth joint almost hairlike, only visible in certain positions .. 4
   Scale-tuft on sixth joint obvious, the scales much broader 5
4. Smaller, blackish species.. .. .. *nigra*, Leic.
   Larger, reddish species .. .. *rubithoracis*, Leic.
5. Scale-tuft on sixth joint very large, the lower scales white .. *fraudatrix*, Theo.
   Scale-tuft on sixth joint smaller, the scales all dark 6
6. Abdomen unbanded .. .. *barkeri* (Theo.).
   Abdomen banded .. .. *taeniata*, Leic.
7. Sixth to eighth joints of male antennae without scale-tufts.. 8
   Sixth to eighth joints of male antennae with scale-tufts 9

8. Male palpi almost as long as the proboscis .. .. .. *hewitti*, Edw.
Male palpi only about half as long as the proboscis .. .. *curtipalpis*, Edw.
9. Male palpi a little shorter than the proboscis; scale-tuft on sixth antennal joint bright yellow.. .. .. *eminentia*, Leic.
Male palpi at least as long as the proboscis; scale-tuft on sixth antennal joint of a duller colour 10
10. Last two joints of male palpi rather longer and distinctly hairy; Ceylon species *uniformis*, Theo.
Last two joints of male palpi rather shorter and almost hairless; Malayan species 11
11. A distinct scale-tuft on the sixth antennal joint of the male *mammilifer*, Leic.
Scales on sixth antennal joint of male hairlike and inconspicuous *minor*, Leic.

Lophoceratomyia being regarded as only a subgenus of *Culex*, the names *nigra* and *taeniata* are both preoccupied, but I refrain from proposing substitutes for them as I am doubtful if they are specificially distinct from *L. rubithoracis* and *L. taeniata* respectively. I have used the name *eminentia*, Leic., instead of the earlier *brevipalpus*, Theo., in order to avoid confusion with *Culex* (*Cyathomyia*) *brevipalpis*, Giles; these names are too much alike for both to be retained.

Lophoceratomyia barkeri, Theo.

I now consider that my *L. quadripalpis* (Bull. Ent. Res., v, p. 80, 1914) is synonymous with *L. barkeri* and *L. sylvestris*.

Lophoceratomyia uniformis, Theo.

I have previously stated (Bull. Ent. Res., v, p. 80, 1914) that *L. uniformis* is identical with *L. mammilifer*, but a more careful examination proves that this is not so. Larval skins of *L. uniformis* from Ceylon, with the adults bred from them, were presented to the museum by Mr. E. E. Green in 1914; the larvae are very peculiar in having the whole integument of the thorax and abdomen covered with minute hairs. I thought that this might prove to be a character of *Lophoceratomyia*, and was much surprised when in 1916 Dr. A. T. Stanton sent larval skins of *L. mammilifer* from Ginting Simpah, Fed. Malay States, which had a normal bare integument. A subsequent re-examination of the adults revealed the difference indicated in the key.

Lophoceratomyia minor, Leic.

The male specimens in Leicester's collection, which apparently can only be this species, differ as follows from his description:—The palpi are barely as long as the proboscis; sixth antennal joint with very inconspicuous hair-like scales on its outer side; the larger claw on the fore and mid legs is toothed as well as the smaller. In spite of these differences I believe I must have correctly identified the specimens, as there are none in the collection which fit Leicester's description, and none of his descriptions fit these specimens better than that of *L. minor*. I do not know whether the name *L. minor* is antedated by *Culex minor*, Theo. (Oct. 1908), so allow it to remain for the present, as *C. minor* is probably synonymous with *C. fuscocephalus*, Theo.

Bred specimens agreeing with those above referred to have been received from Dr. Stanton from Ginting Simpah, Fed. Malay States, 1915. The larval skin is very similar to that of *L. mammilifer* (received from the same place in 1916), but the gills are twice as long as the anal segment instead of only a little longer, and there are some other differences.

Lophoceratomyia cylindrica, Theo.

Culex cylindricus, Theo., Mon. Cul. iii, p. 202 (1903).

The antennal structure of this species is exactly the same as in *L. minutisima* (Theo.), which it also resembles in its banded abdomen.

Lophoceratomyia chaetoventralis, Theo.

Neomelanoconion chaetoventralis, Theo., Mon. Cul. v, p. 461 (1910).

Though known only from the type female, this also is evidently a species of *Lophoceratomyia*. It appears to be very much like *L. cylindrica*, but has white scales round the front margin of the mesonotum, which the latter has not.

Subgenus Micraëdes, Coq.

It is doubtful whether all the species of *Culex* with the palpi equally short in both sexes are genetically related, but it will perhaps be convenient to class them all together in one subgenus. The name of this subgenus should perhaps be *Aëdinus* rather than *Micraëdes*, since Howard, Dyar and Knab include Lutz's genus in the synonymy of *Culex*.

Micraëdes malayi, Leic.

Aëdes malayi, Leic., Cul. of Malaya, p. 184 (1908).

Aioretomyia aëdes, Leic., Cul. of Malaya, p. 189 (1908).

I overlooked the above synonymy in my paper on Synonymy of Oriental Culicidae. The types agree.

Genus Theobaldia, N.-L.

Theobaldia longiareolata, Mcq.

Culex longiariolatus, Mcq., Dipt. Exot. i, p. 34 (1838).

Culex spathipalpis, Rond., Bull. Soc. Ent. It. iv, p. 31 (1872).

Culex serratipes, Becker, Berlin Mitt. Zool. Mus. iv, p. 78 (1908).

As Theobald suggests, it is fairly certain that Macquart's species is the same as Rondani's; it is the only European gnat to which Macquart's description of the venation will apply, and therefore this old name ought to be used. Becker's *C. serratipes* is also quite evidently the same from the description.

It may be mentioned here that Becker's *C. anguste-alatus* and *C. albopalposus* are probably both *Stegomyia fasciata*; the former apparently being described from a specimen with the last two hind tarsal joints broken off, and the latter from one with a rubbed thorax.

Genus Aëdomyia, Theo.

Aëdomyia africana, N.-L. (fig. 10 *c*).

Neveu-Lemaire described this species from a single male which he said had only a median pale ring on the proboscis and no white scales on the palpi. I have not seen

a specimen answering to this description, but the numerous specimens of *Aëdomyia* received from various parts of Africa show a good deal of variation in the amount of white on the proboscis and palpi, and I therefore incline to believe that Neveu-Lemaire only described an unusually dark specimen of the species which is widely distributed in Africa. This species I have previously identified with the Oriental *A. catasticta*; there are, however, slight but apparently constant differences between the two, and I therefore propose to use Neveu-Lemaire's name for what I believe is likely to prove the only African species of the genus.

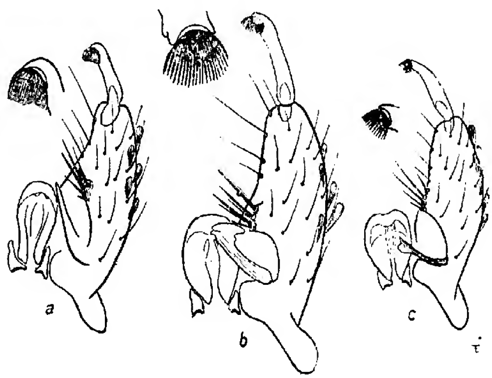

Fig. 10. Male genitalia of *Aëdomyia* seen from below, with tip of clasper further enlarged :—(*a*) *A. squamipennis*, Arr., from British Guiana; (*b*) *A. catasticta*, Knab, from Sarawak; (*c*) *A. africana*, N.-L., from Nigeria.

A. africana differs as follows from *A. catasticta* :—It is on the average distinctly smaller; the wings have a well-defined clear yellow patch at the base just below the costa, in which no darker scales are included; the yellow patch on the mesonotum is more sharply defined and rather larger, and its sides are not indented by patches of dark scales; the claspers of the male genitalia are somewhat narrowed instead of slightly expanded towards the tip, and their terminal spine is divided into about 15 instead of about 20 teeth (fig. 10 *c*).

Figures of the male genitalia of *A. catasticta* and *A. squamipennis* are given for comparison. It is possible that *A. catasticta* is the same as the Australian *A. venustipes*, but this is not likely, since Taylor speaks of white scales being present on most of the joints of the female antennae, whereas in the three species known to me only the first two antennal joints bear scales.

NOTES ON COCCID-INFESTING CHALCIDOIDEA -II.

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In the following descriptions I have dealt mainly with part of a small but valuable collection of Coccid Chalcids, sent by Mr. W. H. Patterson from Aburi, Gold Coast. The excellent condition in which the insects were received may be due to some extent to the fact they were bred specimens, but it also owes something, I think, to the method of packing employed. Into each tube ($1\frac{3}{4}$ in. $\times$ $\frac{1}{2}$ in.) a little melted naphthalene had been run with a piece of moderately thick paper on the top; above this again the Chalcids were loosely enclosed in screws, or (in the case of minute Eulophids and Aphelinines) in small triangles of tissue paper, and the tube coated and sealed with paraffin wax.

Some notes on the methods adopted for the preparation of the specimens for descriptive purposes may be given.

The material was sorted into species and two examples of each sex were selected when available. The first example was relaxed for twenty-four hours, brushed out and set in a drop of water, and when the liquid had nearly dried off, a touch of *thick* gum tragacanth was placed on the tarsi and tips of the antennae and wings. The second specimen, after the wings had been broken off and transferred to clove oil direct, was heated in 10 per cent. caustic potash until a few minutes after it had sunk; next transferred to glacial acetic acid, without washing, and when thoroughly cleared, passed quickly into clove oil direct. In the case of species with a thick, dark, heavily-chitinised integument, which it is desired to study, the opaque sclerites may be treated by Mayer's chlorine method (Arch. Anat. Phys., 1874, p. 321), as follows:—Place a few crystals of potassium chlorate ($KC10_4$) in a watch-glass, and add one or two drops of strong hydrochloric acid (HC1); when the action has taken place (which should be immediately) and the green tinge of nascent chlorine is apparent, dilute with a drop of distilled water, and immerse the sclerites in the liquid. When the chitin is thin, the bleaching will take place quickly; the action should be carefully watched and checked at the point desired by transferring again to the acetic acid and rinsing there. Place next in clove oil; if the integument is very dark and heavily-chitinised do not add any water to the bleaching fluid. Dissections may be effected either in the acetic acid, which is easier, but a little unpleasant to work over, or in oil. From oil the dissections may be mounted in balsam in the usual way, the head and thorax being protected by fragments of cover glass to prevent crushing. By using circular cover slips of $\frac{5}{8}$ in. diameter (No. 1 for preference) the whole of the insect may be conveniently mounted on two 3 in. $\times$ 1 in. slides. The following order of dissection and mounting greatly facilitates descriptions:—antennae and mandibles; first and second maxillae; labrum, hypo- and epi-pharynx; prothorax (sclerites separated and flattened); mesothorax, separated only into notal and sterno-pleural parts; propodeon; abdomen, tergites, sternites, parts of ovipositor, or male genitalia;

wings and legs. The latter parts should be arranged to show both sides; the chaetotaxy of the under surface of the wings and the posterior aspect of the legs (especially the apical armature of the tibiae) is often of great importance, and can be studied accurately only by methods such as are outlined above.

When a species has been founded on a single example, the type is treated in the following way:—the wings on one side having been removed are passed through oil and mounted in balsam; the legs on one side are taken off, heated in potash, put through glacial acetic and oil, and then mounted; in the same way one antenna is mounted, the head being variously treated. If the species be one with a thick deeply sculptured integument, it is best, I think, to treat for a short time with hot potash and then to dissect out the mouth-parts in acid and mount them. A fine pin is now inserted into the cavity made by the removal of the trophi, and the head set aside to dry; after this the smallest possible drop of *viscid* xylol-balsam is employed to fix the head firmly to the pin; the balsam must not be thin or it will run over the sculpture of the frons and ruin the preparation. The specimen may now after relaxing be set on card with the head alongside, one antenna is left on to show the relative length of the scape and the scapal groove, etc. Neither the colour, the metallic lustre, nor the ordinary bristles of strongly chitinised heads will alter by this treatment, but it should not be employed where the bristles are stout, flattened and scale-like, as they are apt to become detached in the process. In such cases one can only dissect the mouth-parts when the specimen has been properly relaxed; the mandibles, however, are hard to remove when the muscles have not previously been softened by caustic potash, and the labrum as often as not is lost or torn; when the head is weakly chitinised and non-metallic, it is perhaps better studied mounted like the legs and wings. Speaking generally, all larger, more heavily-chitinised Chalcids should be carded; theoretically, no doubt, specimens mounted on a pin point or at the end of a long triangle of card give the greatest facility for study, as they can be looked at from all points of view; but in practice the advantages are mainly with material set and gummed down in the way described. The carded specimen is much more safely held; *e.g.*, there are still Walkerian and Westwoodian types in the British Museum collection dating from the forties or earlier in excellent preservation, while many St. Vincent examples (1894) pin-mounted, have been destroyed or become reduced to a thoracic torso through vibration in opening of drawers or rough handling; and if it is desirable to inspect the thoracic sternum the specimen can be floated off in a moment on a drop of water, dried, examined and tacked down again. All small Chalcids are, however, much better mounted in Canada balsam, except such insects as small Pteromalids or Entedonines, whose hard metallic integument appears opaque and without detail under such conditions. With fragile Chalcids (some Aphelinines, Eulophids, Trichogrammatids, etc.) one must be more careful. It is quite safe to bring them at once from potash to glacial acetic acid, but thereafter the specimens must pass successively through half absolute and half acid, and pure absolute alcohol, and be finally brought into oil by placing in a tube graduated from pure oil at the bottom to absolute alcohol at the top.

When one is compelled to make a type of any of the more minute and stoutly built forms (*e.g.*, *Coccophagus*) it is best, I believe, not to mount the insect entire, but to put—of course on the same slide—the following parts under separate cover

slips:—(*a*) head and trunk; (*b*) legs; (*c*) wings; (*d*) antennae, and if possible (*e*) mandibles and trophi. The proportions of tarsal joints and nervures can be judged with accuracy only when the parts are flatly extended. The method of rapid mounting which has been described gives the best results with material which has merely been dried. It may also be used with spirit material, but alcohol has the defect of rapidly becoming a first-rate macerating solution, unless it is used strong (over 80 per cent.) and the tube is at once carefully sealed. When maceration has set in the wings swell, the upper and lower membranes separating, and very frequently a troublesome muddy deposit clogs the fine discal ciliation; the muscles toughen and a much longer treatment with potash is required before transference to acetic acid can be made; the wings also are harder to detach. It cannot indeed be questioned that the best preparations of these organs, giving the crispest images under the microscope, are got from specimens which have never been in any liquid preservative. In detaching the wings, legs or antennae, the dissecting needle should be dipped into oil and passed gently over the surface of the part to be taken off before any pressure is applied at the joint; when the joint is broken the part adheres to the needle and can be at once put in oil.

But, while Chalcids of the largest size may be pinned, and medium-sized species packed in tissue paper, it is a distinct advantage to have the smallest forms sent in spirit—not that alcohol is of great value as a preservative, but simply that it prevents shaking of the insects and so protects the chaetotaxy and appendages from those injuries which packing in even the softest tissue paper cannot wholly obviate. Care must be taken to fill the tube completely with spirit and the cork should have a *smooth* surface and exactly fit the tube.

It is hardly necessary to add that the foregoing notes apply to material whose external morphology alone has to be investigated. For histological purposes more elaborate methods of preservation are required. If corrosive sublimate (HgCl), alone or in combination, is used as a fixative, it is perhaps well to remind collectors that washing out with iodine in alcohol must be done *immediately* after fixing.

In the following pages the use of the word "scrobes" has been abandoned. Properly, the term, denoting the frontal furrow in which the antenna rises, includes (*a*) the groove behind the scape, (*b*) the rim (torulus), within which the bulla is accommodated, having at its lower angle the real socket of the antenna (*c*) and occasionally* extending a little round and below the torulus. Some writers have applied the term (1) to the facial impression; others (2) to what I call the post scapal hollow; others again (3) to the torulus proper; neither (1) nor (2) can be supported, and (3) has propriety only in cases where there is no facial impression and the scapal grooves are obsolete, i.e., when the scrobes are reduced to the toruli alone.

In describing the abdomen (♀) seven tergites and five sternites may be recognised; normally the first five tergites are simple and transverse, the sixth bears the spiracles and may be separated into a tergite and two pleural parts—each pleurite with a stigma; the seventh tergite bears the setigerous processes (2). I can see no objection, for descriptive purposes at least, to numbering the tergites 1–7 and the sternites 1–5; to homologise them strictly with the segments to which they belong

* *E.g.*, in *Coccidoxenus coelops*, see fig. 2 *a*, *b*, p. 239.

would involve using a number instead of the terms "propodeon" and "sheath of the ovipositor," which seems a needless simplification. The measurements of the tarsal joints are made along the dorsal edge and do not include the claw. By "marginal vein" unless otherwise indicated, is to be understood strictly the costal portion or abscissa of that vein.

Family *ENCYRTIDAE.*

The present classification of the ENCYRTIDAE according to the number of mandibular teeth is entirely artificial, and, if pressed, puts members of the same genus into different tribes. In tridentate groups species occur with the upper pair of teeth fused into one broad cutting edge. There are described below two such species, which are formally Ectromines, but I believe that their Bothriothoracine appearance is a truer index of their relationship.

These insects run down to *Pentelicus*, Howard (Proc. U.S. Nat. Mus., xvii, p. 611, 1895) in Ashmead's table (ibid., xxii, p. 336, 1900) if one begins at the Mirine section. In the Ectromine section of Mr. Girault's keys (Mem. Queensl. Mus., iv, p. 181, 1915) they run to *Coccidoxenus*, Crawf. (1913). Proofs of figs. 2 and 3 were sent to Dr. L. O. Howard, whose reply has fortunately come to hand just before the present paper went to press. Dr. Howard writes that Mr. Girault considers that the drawings indicate *Coccidoxenus*, Crawf., but with a more pronounced sculpture than has yet been found in that genus. *Pentelicus*, How., he adds, is apparently the same as *Hemaenasius*, Ashm. (Proc. U.S.A. Mus., xxii, pp. 336, 374, 1900)—the two differing however in sculpture—a genus with which the African forms have no very close relationship. It is in my opinion undesirable to erect even a subgenus on sculpture alone, particularly in a section already probably overburdened with subdivisions, and the species described below have therefore been placed in *Coccidoxenus*, Crawf.

Genus ANERISTUS, How.

Aneristus, Howard, Canadian Entom., xxvii, 1895, p. 351.

Aneristus croconotus, sp. nov. (fig. 1).

♀. *A blackish or blackish-brown, dully shining species with a conspicuous yellow notal blotch.*

Eyes dark chocolate-brown; vertex (a little paler), frons and genae fuscous, with black bristles. Antennae blackish brown. Thorax: prothorax entirely, mesopleurae, sternum and scutellum blackish brown; anteriorly the mid lobe is narrowly blackish where overlapped by the pronotum, and there is another presutural fuscous or blackish band extending across the side lobes, except narrowly anteriorly. The greater part of the mid lobe is bright lemon-yellow, which appears again linearly on the broad petiole; otherwise the metathorax, propodeon and abdomen are blackish, the abdominal tergites having a purplish lustre. Fore wings: the submarginal and marginal veins pale (to one-half), the latter apically darker; the blotch extends *completely* across the wing (fig. 1), which is very shortly darkened at the radix. Legs: all the femora, the fore and mid coxae and tibiae, with their spurs, claws and empodia, and first hind tarsal joint to beyond one-half, blackish; fore and mid tarsus fuscous; hind tarsus mainly whitish. In the hind leg the coxa is pale laterally on both aspects,

broadly dark above, and narrowly beneath; the tibia is apically paler, and darker near the base, but with indefinite smoky streaks dorsally and ventrally, except on the apical third. Ovipositor reddish brown.

Head just wider than deep (15 : 14). Eyes large, with minute scattered bristles, occupying five-eighths of the depth of the head, or twice the genal space; nearest to one another just before a third from the anterior ocellus to the middle of the clypeal edge; at this point separated by three-fourths of a diameter, and by about two diameters on the base line; from in front the curve of the eyes is continued across the swollen vertex, but ventrally the outline contracts to the somewhat narrowed mouth-opening which is transversely less than the shortest distance between the

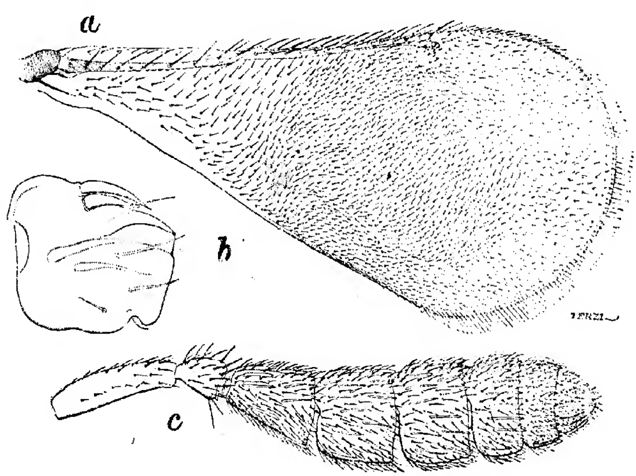

Fig. 1. *Aneristus croconotus*, sp. n.; ♀, (*a*) right fore wing; (*b*) mandible; (*c*) antenna.

eyes. Mouth-edge straight broadly at either side, the middle one-fifth occupied by a low slightly salient clypeal lobe; post-scapal furrows deep, uniting before the anterior ocellus. Toruli large, oblong-oval, separated by about twice their breadth, and distinctly remote from the clypeal edge, lying for one-third above the base line of the eyes. Genal keel traceable, at least just below the eye. On vertex and frons the pattern is regular, somewhat coarse and raised, the cells being pentagonal or quadrate, smoother between the toruli, finer towards the genae; on the occiput and genae the pattern is larger and transversely drawn out; along the occipital margin are some short spinose bristles (about 6 : 6) with many more (over 30) very minute, which form an arched submarginal row, continuing down parallel with the edge till they mingle with the genal bristles. About 12 bristles on the ocellar triangle. The orbital bristles (18–20 on each side) are unusually distinct superiorly, but become less conspicuous below; between the scapal furrow and the orbit are about 30 bristles, and there are about as many more very minute ones in the lower frontal angle, the change in the calibre of these bristles taking place suddenly nearly at the base line of the eye.

At each side of the mouth-opening are 3–4 longer bristles; on the mid clypeal lobe 4 short hyaline marginal spines, and about 6 more superiorly on or near the edge; the genae bear 2–3 submarginal rows of bristles. In life the vertex and face are probably swollen.

Antennae (fig. 1 *c*) length, nearly ·9 mm., and ·14 mm. deep on the third funicular joint. Scape over four and a half times as long as broad, with large coarsely raised pattern, no ventral bristles, but one subapical and subventral, and 8–9 median to subdorsal, and chiefly on the apical half, on each side. Pedicel (3 : 2) three-eighths of the scape, but a little broader, with the pattern of the scape. Though articulated medianly or submedianly, the appearance of the funicle suggests a subdorsal insertion of the joints; the upper basal angle of the second and third joints of the funicle and the first of the club swells backwardly, fitting into a dorsal apical hollow of the preceding joint. The first funicular joint appears longer than it really is, being only one-twelfth longer than the second; indeed the two are equal if the dorsal swelling of the second is reckoned. The joints are in the proportion 12 : 11 : 9, with corresponding width 7 : 10 : 11; in the club the segments are approximately 11 : 8 : 10, with breadths 18 : 16 : 11; the club is absolutely longer than the scape; and a little over four-fifths of the last two funicular joints together. Sensoria, in all, the first funicular has 11–12; the second 22; the third 27; club (*a*) 24, (*b*) 19–20, (*c*) 12–14. On the terminal sense-organ are about 10 short hyaline spines.

Mouth-parts. Labrum with 4 (?) bristles; epipharynx anteriorly triangular. Mandibles (2 : 1) (fig. 1) with the second ventral spine very stout; 3 bristles externally on the apical half, the "toe" of the cardo long and narrow; stipes with 8 bristles, mainly at the side; one on the mentum, sub-basal. Maxillary palpus segmented (1 : 2), over twice as long as the labial; 4 setigerous pustules on the ligula.

Thorax. Prothorax: pronotum when flattened out, quite straight behind, with a posterior row of 22–24 bristles; one bristle on each side, above the small semicircular spiracular emargination, much more developed. Besides the posterior row there are about 90 bristles in 3–4 transverse rows; the surface is evenly raised, and there is a slight thickening at the spiracle. Mesothorax: mid lobe with 4 stouter bristles inside each parapsidal furrow, 4 similar ones before the suture in a transverse row; the surface of the lobe densely set with bristles (about 150), which increase in calibre posteriorly; side lobes with 4 bristles; axillae, 2; scutellum, more sparsely set, 20–30 bristles, 2 posteriorly much stouter and longer. Sternopleurae, pattern faint, antero-ventrally drawn out on the epimeron so that the sclerite seems covered with very fine striae, coarsest and most regular on the sternum posteriorly; 2 (1 : 1) central posterior bristles, and one at each postero-lateral and antero-lateral angle. The upper part of the prepectus has a distinct coarse regular raised pattern. Metanotum: side-pieces with one or two transverse rugae behind, which continue anterolaterally across on to the propodeon, in the region usually occupied by the sulcus, as a raised shortly-ridged reticulation.

Propodeon narrowed medianly, not wider there than the post-scutellum; surface smooth; two strong internal rods in the position of lateral keels; beyond them, and remote from the sides, are the moderate-sized, transverse oval spiracles, a little narrowed at the inner end.

Wings. Fore wings (fig. 1) nearly two and a half times as long as broad; length, ·95 mm.; breadth, ·4 mm. Submarginal: marginal, 7 : 9; radius with 4 cells; submarginal up to the clear pustules with 6–7 bristles; 9–10 fine bristles in the submarginal cell; 14 thick bristles *on* the marginal (double from the fifth onwards, the second bristle stout but shorter) and as many more projecting over the edge from below. Surface otherwise evenly set with bristles, which are stronger on the cloud. Hind wings four times as long as broad; length, ·82 mm.; breadth, ·21 mm.; marginal vein with 27 bristles before the hooks; 4–5 minute bristles at the hooks; basally the hind wing is posteriorly concave.

Fore legs: femur (4 : 1) one-third longer than the tibia; anteriorly a ventral row of 7–8 bristles from the base to two-thirds; dorsally and subdorsally covered with bristles to above one-half; three widely spaced bristles (the first after two-thirds) before the apex, the most distal longest and strongest; posteriorly 8–9 subventral bristles in two irregular rows. Tibia (4 : 1) rather flat; apical comb with 4 spines; comb of first tarsal joint sloping across the apical half of the joint, containing 10 thin spines. *Mid-legs* long; coxae with 4 major bristles and about 30 smaller, anteriorly; femur (5 : 1) slender. At the base of the tibiae (17 : 2) are 5 stout sharp spines, two anterior, two posterior, and one on the dorsal edge; the spur just exceeds the first tarsal joint, which bears besides the usual plantar spinules an antero-lateral nearly ventral row (7–8) of sharp hyaline spines. *Hind legs*: coxae (5 : 3) bare on the upper two-thirds, and three-fourths of the femur in length; femur (10 : 3) nearly bare; tibiae (nearly 7 : 1) with 11–12 spines in the comb; the dorsal bristles of the tibiae are stouter from one-half to the apex.

In the fore tarsus the proportions of the first four joints are 8, 4, 3, 3; in the mid and hind legs the ratio is 19, 8, 7, 5.

Abdomen: first tergite not markedly longer than the others; all seven with *one* row of bristles, 6 postero-medianly straight. Between the spiracles 8–9 bristles; behind and between the setigerous processes are 12 bristles.

Length 1·5 mm.—1·6 mm.; alar expanse, about $2\frac{1}{2}$ mm.

♂. Differs from the ♀ in the hyaline wings and completely black thorax and abdomen, the latter submetallic dark purple above. Head: the vertex and frons below the anterior ocellus (the upper corners of the frontal sclerites, in fact) very narrowly darker than in the ♀; the remainder of the face and mouth-edge, and posteriorly up the genae half-way to the level base line of the eyes, flavescent, the trophi being mainly yellowish, except for the darker stipes, and second maxillary joint towards the apex. Antennae not so black as in the ♀; scape, except obscurely at the apex, and under side of the pedicel yellow. Fore legs entirely, apex of mid coxae, the trochanter, femur and tarsus, hind coxae, trochanter and tarsus, except last joint, pale flavescent; mid coxae above hind femora and tibiae entirely blackish; mid tibiae pale with a faint fuscous tinge. All the claws, empodia, and fifth hind tarsal joint blackish.

Head very broad, much wider (19 : 16) than in the ♀. Eyes with distinct, though scattered, rigid pubescence; separated just before one-fifth from the anterior ocellus by two, and on the base line by three diameters. Toruli a little higher than in the ♀, over one-half lying above the base line of the eyes; scapal furrows short, uniting

lower down than in the ♀, at a point just beyond half-way between the toruli and the anterior ocellus. The bristles are fewer on the face, which is broadly bare medianly, and fine from one-half downwards; as in the ♀, the triangle between the toruli bears about 12 bristles.

Antennae: length, ·87 mm.; scape (nearly 4 : 1) shorter than the club (15 : 17); pedicel (11 : 10) swollen, two-sevenths of the scape, or one-third of the first funicular. Funicular joints in the ratio 12½ : 11 : 9, with a breadth of 7; the club in the same scale is 16½, segmented in the ratio 7 : 6 : 7; the sensoria are higher and much more numerous than in the ♀, *e.g.*, the first funicular bears about 40, and the last segment of the club 10.

Mouth-parts: mandible (4 : 3) broader than in the ♀.

Thorax. Everywhere the pattern is more boldly raised, and there are some additional bristles on the pronotum and mid lobe of mesonotum. The propodeal spiracles are oval, and outside them anteriorly the surface is reticulate, not rugose, with 5–6 bristles.

Wings a little over twice as long as broad; length 1 mm.; breadth, ·47 mm. The submarginal vein is a little shorter and the marginal correspondingly longer than in the ♀; the submarginal thus bears one longer bristle fewer, and the marginal has 1–2 extra added to its rows. In the submarginal cell is a row of a dozen short bristles with 1–2 extra at the apex; below the marginal (to near the radius) the discal ciliation is distinct, about twice the breadth of the vein. Hind wing: length, ·85 mm.; breadth, ·25 mm. Chaetotaxy of veins as in the ♀.

Abdomen: sixth tergite narrowly slit medianly, with 6 bristles between the spiracles; seventh in two quadrate lobes, with 3 bristles each; the seventh sternite bears 4–5 bristles on each side below the penis.

Length, 1·25 mm.; alar expanse, nearly 2½ mm.

Type—♀ in the British Museum.

Gold Coast: Aburi (*W. H. Patterson*); (*a*) ex *Lecanium* sp. on orange, 2 ♂♂, 3 ♀♀; (*b*) reared from *Lecanium* sp. on *Tephrosia vogilii*, 19.xii.1915, 1 ♂.

This Coccophagine is a typical *Aneristus* in possessing a short scape and flattened funicle in both sexes. The insertion of the antennae is, however, higher up than in the genotype (*Aneristus ceroplastae*, How., loc. cit.) and the bristles of the dorsal edge of the tibia are not markedly strong. The species is large and very distinct.

Genus Coccidoxenus, Crawf. (1913).

Coccidoxenus, Crawf., Proc. U.S. Nat. Mus., xlv, p. 248, fig. 1 (1913).

Type.—Coccidoxenus *portoricensis*, Crawf. (l.c.).

Coccidoxenus coelops, sp. nov. (figs. 2 *a–c*, 3 *a–c*).

♀. *A large blue-black species with wholly clear wings and distinctly paler tipped ovipositor.*

Head dull violet-black, with metallic reflections at the junction of the scapal furrows, and at each side in the hollows above the mouth-edge. Antennae blackish-brown; the bullae paler. Thorax like the head, but duller, with green metallic reflections narrowly on the mid scutellum. Wings: both pairs entirely hyaline;

veins of fore wings brown, and though darker at the base of the radius, this colour does not spread to the surrounding membrane. Legs: coxae (with violaceous reflections), tibiae, femora and claws blackish-brown; non-metallic, with knees shortly and indefinitely paler; fore tarsi entirely pale fuscous; mid tarsus the same, but the first joint mainly whitish; hind tarsus with joints 1–3 whitish, 4 and 5 brown. Abdomen, except narrowly near the petiole, dark metallic greenish-blue; elsewhere black, with dull cupreous reflections. The base of the ovipositor is blackish-brown; the projecting tip, clear brown.

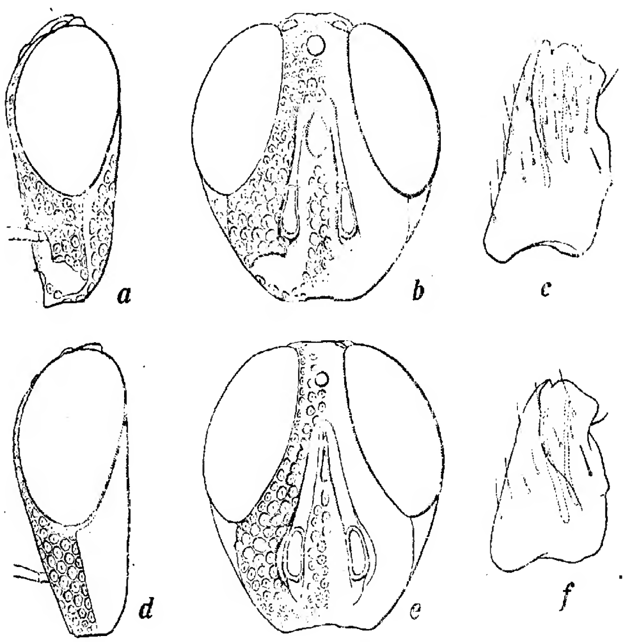

Fig. 2. *Coccidoxenus coclops*, sp. n., ♀; (*a*) head, profile; (*b*) head, front view; (*c*) mandible.
Coccidoxenus obscuratus, sp. n., ♀; (*d*) head, profile; (*e*) head, front view; (*f*) mandible.

Head barely broader than deep (12 : 11), short; occiput broadly and deeply concave; lateral ocelli about a diameter from the occipital edge and half a diameter from the orbits respectively, lying in an equilateral triangle. Eyes in profile twice as long as the malar keel, or five-eighths the depth of the head, separated at their nearest (at the lateral ocelli) by one-fourth, and on the base line of the eye by nearly three-fourths the breadth of the head. The mouth-opening is about two-fifths of the width of the head; clypeal edge straight, cut back shortly from the mouth-edge. Toruli long, triangular, with rounded angles, separated by a little over their length from the mouth-edge, and cutting the base line of the eyes superiorly; separated by about

their own length; scapal grooves deep (the space between raised, not prominent in profile, but carinate between the toruli), not meeting in a sharp angle, but separated superiorly by a small flat area. Below the toruli, the scrobe continues as a hollow above the mouth-edge, extending laterally to the genal keel. On the vertex and frons, between the orbits and scapal grooves, the entire surface is covered with large thimble-like setigerous punctures; on the elevation between the grooves there are about twenty smaller, more widely placed punctures; similar sparser and smaller punctures are seen above the clypeus and sides of the mouth-opening. Above the mouth, the surface for a short distance is nearly smooth between the punctures, but on the vertex the unpunctured surface is strongly and finely raised reticulate; the genae behind the malar keel are punctured similarly to the lower lateral angle of the frons in front.

Antennae slender, the club not greatly expanded, and only a little over one-third of the funicle; length, 1·4 mm. of which the scape is ·47 mm.; bulla elongate, two-ninths of the scape; the latter nearly six times as long as broad, narrow basally, and expanded on the apical two-thirds; pedicel (13 : 6) one-third of the scape, but barely as wide; as long as the first funicular. First four joints of funicle cylindrical: the fifth quadrate; the sixth transverse; in the ratio 18 : 14 : 14 : 12 : 11 : 10; the breadth increasing from 6 on the first joint to 11 on the sixth; club (in the same scale) 10 : 7 : 12, with a breadth of 16. Except on the last two segments of the club the bristles are stout; sensoria—first funicular, 1; second, 3; third, 4; fourth, 5; fifth, 8; sixth, 10; club, 14, 19, 8.

Mouth-parts: mandibles (17 : 10) elongate, with one small ventral tooth, above which is a broad concave lobe (?two nearly fused teeth), the upper internal one much shorter; the upper basal angle broadly bare; 30-40 bristles on the rest of the outer surface. Stipes coarsely reticulate; one long bristle behind the palpus, and another about the middle; maxillary palpus, 5 : 4 : 4 : 8; mentum rough; pattern a little finer than on the stipes; bristles 3 : 3. The galea is covered with bristles, 8–9 standing at the edge, on which, at the upper basal angle, there are also 4–5 short clear spines.

Thorax stout and broad; pro- and meso-notum coriaceous, *i.e.* the pattern fine, transversely drawn out, with numerous close, very short striae, and densely set with setigerous punctures much smaller than those on the head; scutellum (two-thirds as long as the pro- and meso-nota) longitudinally striate; the pattern more highly raised. Propodeon very smooth centrally, swollen, round and rougher below the larger, broadly oval spiracle.

Wings two and four-fifths as long as broad; length, 2·1 mm.; breadth, ·75 mm.; submarginal five times the radius; the marginal punctiform and not reaching the costa; the post-marginal not half the radius. Submarginal with 15 bristles; 4 bristles on the costa, at base of radius and on postmarginal; 7 bristles at the root of the radius, and 8–9 on it or at the sides. At the apex of the submarginal cell is a row of 10 short dark bristles, and 6–7 longer nearly hyaline ones rise from the membrane underneath; besides these there are numerous minute hyaline bristles, many submarginal in position, in from two to four rows. The majority of these bristles rise from below, but at the base are two short rows from the upper surface. The general distribution of the bristles is shown in fig. 3 *a, c*; the two clear areas—the basal triangle and the

median band—bear, chiefly underneath, many minute hyaline bristles, which are not shown in the figure; except behind the radius, beyond one-half, there are no defined tracts in the chaetotaxy, but the bristles apically tend to flow to the termen in isoclinal lines. Hind wings three times as long as broad; length, 1·2 mm., breadth, ·4 mm.; about a dozen minute bristles along the edge of the submarginal cell, before the apex; ten bristles behind the hooks; bristles on the apical half extremely minute and weak.

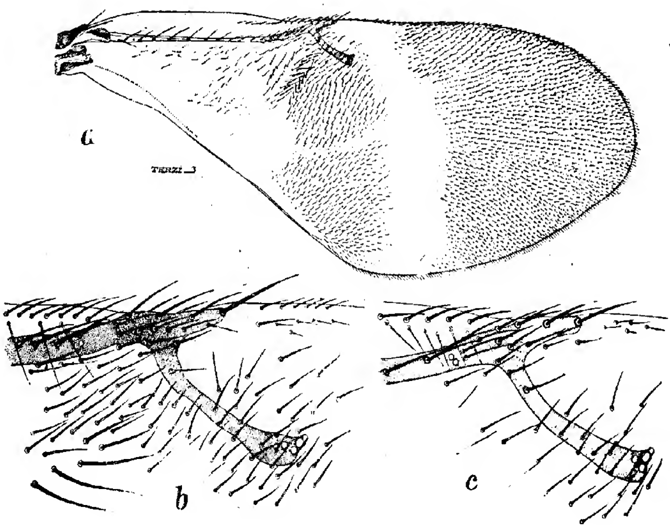

Fig. 3. *Coccidoxenus coelops*, sp. n., ♀; (*a*) right fore wing; (*c*) radius. *Coccidoxenus obscuratus*, sp. n., ♀; (*b*) radius of right fore wing.

Fore legs: coxae (3 : 2); femur broadened rather suddenly, ventral edge very straight; dorsal edge subconcave; 4–5 of the subventral bristles, at the apex, are stronger; tibia (4 : 1), the bristles of the dorsal edge stouter; apical comb of 7, and 3 other short spines at the upper apical angle; tarsal comb of 16–17 spines. *Mid legs*: coxae (4 : 3), anteriorly finely raised reticulate, with very many short bristles; posteriorly bare and minutely transversely striate; femur, about 9 : 2; tibia nearly 6 : 1 at apex and 12 : 1 in middle, slender on basal two-thirds, then expanded, with 9 peg-like spines on anterior apical edge; spur exceeding the first tarsal joint. The first four joints of the tarsus bear 28, 12, 10, and 6 peg-like spines, respectively, and 5-6 of the ordinary plantar or lateral bristles of the fifth joint are spinose. Hind coxae (6 : 5) rough, with 4 long bristles above the trochanter; femur, 4 : 1; tibia

(19 : 3) with the apical comb ∧-shaped, containing about 30 spines. On the posterior aspect is a somewhat irregular median row, indistinct both at the base and apex, of stronger bristles. There are two apical spurs. Proportions of the tarsal joints :—

Front ..	9	7	6	5	9
Mid ..	18	8	5	6	9
Hind ..	18	11	7	6	9

Abdomen broad at the base, conic oval, produced anally; sheath distinctly developed; ovipositor projecting.

Length nearly 3 mm.; alar expanse, 5 mm.

Type—♀ in the British Museum.

SOUTHERN NIGERIA: bred from *Ceroplastes vuilleti*, Marchal (*Dr. W. A. Lamborn*).

Coccidoxenus obscuratus, sp. n. (figs. 2 *d–f*, 3 *b*).

Antennae not quite so dark as in *P. coelops*; face uniformly dull, refringent, not gleaming above the mouth-edge. Beyond the clear arc in the middle of the fore wings the membrane is very faintly tinted, while below the radius and apex of the submarginal there is a distinct cloud, extending to the hind margin. The first mid tarsal joint only slightly whitish near the base, while the last three hind tarsal joints are brown. *Head* with practically the dimensions and, in general, the puncturation of *P. coelops*, but differing as follows:—narrower across the vertex; at the level of the lateral ocelli one-sixth of the width of the head; ocelli in an isosceles triangle, the lateral pair more remote from the occipital margin (one and a half diameters); toruli nearer the clypeal edge (just under their own length) and wider apart; post-scapal furrows meeting superiorly in a sharp angle, the enclosed area nearly flat, with fewer punctures, neither salient nor medianly subcarinate above the clypeus, no hollow from the toruli to the genal keel; genal surface at most raised reticulate, without thimble-like punctures behind the keel; facial pubescence not so strong as in *coelops*. In this species the eyes are apparently quite bare when seen with a Zeiss binocular × 88; under the same conditions, the eyes in *coelops* are very minutely and sparsely pubescent.

Antennae: length 1·2 mm., of which the scape is ·37 mm.; scape exactly 6 : 1; pedicel (5 : 3) shorter than in *coelops*; the four cylindrical joints in the funicle are here relatively shorter and wider—*e.g.*, in *coelops* the first funicular is three, in *umbratus* only two and a half times as long as broad; club (3 : 2) short and broad (in *coelops* 15 : 8), more abruptly dilated, three and a third times as broad as the first funicular (in *coelops* two and two-thirds).

Mouth-parts: labrum with 7 bristles, its edge straight (concave in *coelops* ?); mandibles broader than in *coelops* (15 : 10), with the upper apical broad lobe practically straight-edged, and the lower tooth very small; about 20 external bristles. The third joint of the maxillary palpus is shorter than the second, and the fourth broader than in *coelops*; bristles of the galea finer, no spines at the upper basal angle.

Wings: fore wings shorter and broader than in *coelops*; length, 1·75 mm., breadth, ·77 mm.; submarginal to radius as in *coelops*, but the post-marginal even more rudimentary than in that species —one-third of the radius; the discal ciliation is a little stronger and denser, the proximal angle between radius and marginal being

entirely filled with bristles, while beyond the radius is a clump of bristles. Hind wings: length, 1·2 mm.; breadth, ·4 mm.; a row of 4 minute bristles along the middle of the submarginal cell, and none at the edge.

Legs: pattern of coxae, etc., more strongly raised; mid tibiae a little shorter; 10 peg-like spines on the fourth tarsal joint; comb of hind tibiae with 17–18 bristles, those near the upper apical angle stouter, broader and wider apart; first hind tarsal joint distinctly shorter (7 : 9) than the corresponding joint of the mid legs, the proportions of the hind tarsus being :—14; 8; 7, 5, 8.

Abdomen short, rounded posteriorly, two-thirds of the thorax; ovipositor not exserted.

Length, over 2 mm.; expanse, 4½ mm.

Type—♀ in the British Museum.

GOLD COAST: Aburi, 2 ♀♀ bred from *Lecanium somereni*, 23.xii.15. (*W. H. Patterson.*)

Genus CHILONEURUS, Westw.

Chiloneurus, Westwood, Philos. Mag., iii, 1833, p. 343.

Of the two species described below, one (*C. afer*, sp. n.) appears to occupy a more isolated position in the genus on account of the extraordinary development of the scape and club of its antenna. It does not range itself very near any of the North American species keyed by Mr. A. B. Gahan (Ann. Ent. Soc. Amer., vii, no. 3, Sept. 1914). The second species (*C. cyanonotus*, sp. n.) resembles many of its congeners, and is evidently close to *C. dactylopii*, Howard (Descr. N. Amer. Chalcid., Bull. Dept. Agric. Ent., no. 5, 1885, p. 17), but the pedicel is longer in the African species, being practically equal to the first three normal funicular joints (in *dactylopii* it equals the first two. Like *C. formosus*, Boh. (Svensk. Vet.-Akad. Handl., ix, 1852, p. 183) *C. cyanonotus* has the mesonotum parti-coloured, but in the genotype the scutellum is entirely non-metallic and pale. In *C. elegans*, Dalm., (Svensk. Vet.-Akad. Handl., xli., 1820, p. 151) the scutellum is also yellow and at least the first four funicular joints are cylindrical. In wing pattern *C. cyanonotus* approaches *C. obscurus*, Silvestri (Boll. Lab. Zool. Portici, ix, 1915, p. 297), but the antennae are quite different, *C. obscurus* belonging to the section with a short club.

This genus is one in which the sculpture and reticulation repay careful study for an understanding both of specific differences and of the colour-play and refringence to which the great beauty of these insects is largely due; there is always one point (i.e., directly above the cells) from which the refringent surfaces appear to be quite dull. In specimens which have been gummed down, the flattening of the club is generally exaggerated; the breadth of this joint should therefore be taken from a balsam mount under as little pressure as possible.

Chiloneurus afer, sp. nov. (figs. 4–6).

♀. A nearly black species, notal and sterno-pleural thoracic surfaces concolorous; the flattened portion of the face and lower genae behind non-metallic, reddish. Vertex, frons and thorax mainly very dull dark metallic green, with lines of blue at the sutures; pleurae dark blue; the scutellum, from above quite mat, is in side view metallic refringent. Propodeon and abdomen shining purplish or cupreous

black; the projecting portion of the sheath pale, nearly yellow. Antennae with the scape, except apically, pedicel superiorly, and club black; the rest white. Fore wings with the veins embrowned, the junction of the marginal and submarginal nearly hyaline; behind the submarginal, and narrowly round the apex, at the end of the radius, and indefinitely above the frenulum, hyaline; hind wings with a dark spot on nervure at base and at hooks. Fore legs (entirely) and hind coxae (except for a small faint dusky spot externally at the base) nearly white; mid coxae dark, paler apically; trochanters white. All the tarsi and claws pale, yellowish, the fore pair a little darker; fore femora nearly white on more than the basal third, followed by a broad, completely transverse smoky band, which ventrally reaches nearly to the apex, but stops dorsally at three-fourths from the base, leaving the apex dorsally clear and nearly white; fore tibia narrowly pale at the extreme base, but for the most part blackish, paler towards the apex, especially along the edges. Mid femora pale, but a narrow blackish band from the ventral apical angle slopes upwards to the dorsal edge behind the apex; on the pale tibia there is a clear basal dorsal spot followed by a narrow band which crosses the joint and extends in a dusky stretch along the dorsal edge. In the hind legs, the knees are narrowly nearly black, the femora dusky and paler at the base, especially ventrally; the tibia darker medianly, pale towards the apex, as well as shortly just beyond the base.

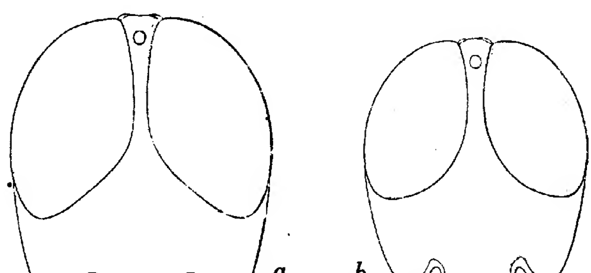

Fig. 4. Heads of (*a*) *Chiloneurus afer*, sp. n., ♀, front view; (*b*) *C. cyanonotus*, sp. n., ♀, front view.

Head, from in front, distinctly deeper than wide (12 : 11). Eyes large, extending over seven-twelfths of the depth, so broad as nearly to obliterate the frons, which at its narrowest (at a point below one-fourth from the vertex to mouth-edge) is less than one-eighteenth of the width of the head; at the lateral ocelli the orbits are from one-sixth to one-seventh of the width apart, but they converge again in a remarkable manner inferiorly (fig. 4 *a*). Toruli (7 : 4) wide apart (entirely outside a line drawn from the corner of the clypeus to the orbit, before the latter diverges outwardly) sloping outwardly and ventrally, separated from one another above by twice, and below by nearly three times their length, distant from the mouth-edge two-fifths of a diameter; clypeal edge straight and narrow, only six-sevenths the length of the torulus. On the vertex and frons downwards to a little above the clypeus, above the

toruli; and ventro-laterally nearly to the genae, the entire surface is much raised-reticulate, the walls of the cells appreciably thickened, producing the effect described in the colour notes. The pattern is fine, especially where the eyes approach one another most nearly; each little cell has, under a high power, an appreciable depth, yet the surface cannot correctly be described as pitted or punctured. Where the pattern is thus greatly raised there are no bristles, except for the usual row (minute) on the orbits; between the toruli and on the clypeus there are in all about 30 minute bristles, 2 (1 : 1) longer, near the clypeal edge above, and 4 (?) from below; there are a few bristles on the genae, and upwards towards the occiput, on which the pattern is long drawn out, but little raised.

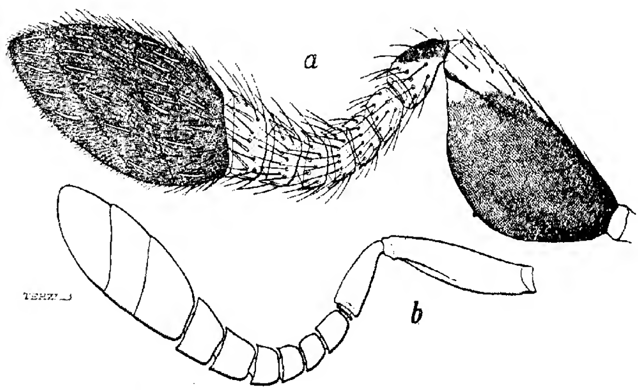

Fig. 5. Left antenna, outer aspect, of (a) *Chiloneurus afer*, sp. n., ♀; (b) *C. cyanonotus*, sp. n., ♀.

Mouth-parts: mandibles (5 : 3) (fig. 6 *b*) elongate, with practically only 2 teeth, the upper pair fused, with a single broad lobe; trophi with a coarse raised pattern on the stipes and mentum, which bears two central bristles; maxillary palpus, 15 : 10 : 15 : 27; the fourth joint being relatively longer than in the next species and a little narrower (3 : 1).

Antennae (fig. 5 *a*): length, ·8 mm. Scape (19 : 10) enormously dilated, with coarse reticulation; bare on the outer aspect; many regularly but rather sparsely set bristles on the inside; the last row standing somewhat above the ventral edge. The scape is shorter (10 : 11) and a little broader than the club, and just equal to the funicle. Pedicel (5 : 3) about one-third of the scape in length; longer than any of the funicular joints, which are all transverse. In the funicle, joints 1–4 are wider ventrally than dorsally, in the fifth the sides are about equal, and in the sixth the dorsal edge is longer, thus giving the antenna its characteristic medianly decurved appearance. The bristles in the funicle are rather long; joints 5 and 6 bear four sensoria each; the club is nearly twice (12 : 7) as broad as the sixth funicular, which is twice as broad as the first, and bears a large ventral sense-organ and 10, 10, 7–8 sensoria.

Thorax: pronotum with the pattern everywhere distinct, transverse on more than the anterior (ventral) half, raised definitely only on the posterior half; the last two rows of cells with thickened walls, but the extreme postero-lateral angles narrowly nearly smooth; the posterior row of bristles (24–26) stands medianly almost at the edge, but passing towards the spiracle in front of the smoother postero-lateral angles; on the raised area in front of the regular row are one or two bristles, while on the smoother descending area are (*a*) 4 minute bristles (2 : 2) just above the neck, (*b*) an isolated bristle midway between each anterior bristle of these pairs and the side of the sclerite, and (*c*) 2–3 bristles, wide apart, on each side of the mid line just in front of the raised area (this arrangement occurs also in the following species). Prosternum transverse diamond-shaped,v ery slightly truncate posteriorly; pattern coarse, raised, and only two minute median bristles (1 : 1) exactly on the hind edge. Mesonotum except anteriorly (below the pronotum) and narrowly before the suture, where there is a moderate normal raised reticulation,

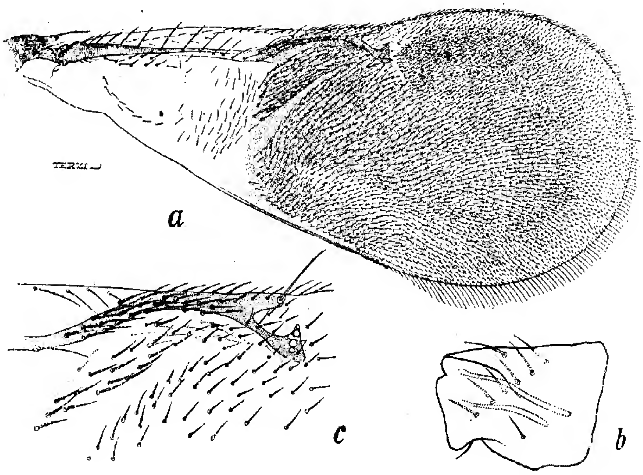

Fig. 6. *Chiloneurus afer*, sp. n., ♀; (*a*) right fore wing; (*b*) left mandible. *C. cyanonotus*, sp. n., ♀; (*c*) radius of right fore wing.

with the entire surface covered by much raised fine elongate setigerous cells, the bristles being sparser anteriorly. Axillae (9–10 bristles) and scutellum with regular much raised cells with thickened walls; besides the patch of modified bristles the scutellum bears upwards of 40 ordinary bristles. Sternopleurae with regular raised pattern, coarsest on sternum, which bears 12–14 minute bristles postero-medianly, and on pleurae anteriorly, and finest on the middle of the latter; behind, especially ventrally, the pleurae are striate.

Wings: fore wings (fig. 6 *a*) nearly two and a half times as long as broad; length, 1·1 mm.; breadth, ·45 mm.; submarginal: marginal: radius: post-marginal, approximately in the ratio 8 : 3; 1 : 1, the last two more nearly 4 : 3. There are 10 heavier and 4–5 hyaline bristles on the submarginal and base of the marginal;

behind the marginal are 6 rows of heavy bristles on the basal side of the clear line; the radius bears, on the upper surface 2 dark bristles at the base and 1 at one-third from the base. Hind wings over three times as long as broad: length, ·83 mm.; breadth, ·25 mm.; 6 minute bristles at the hooks.

Legs similar to those of *C. cyanonotus.* Fore legs with the femur shorter (24 : 7); tarsal comb with 15–16 spines; tarsus as in *cyanonotus.* Mid legs with the tibia not so broad apically (about 2 : 11); an extra spine on the fourth tarsal joint; first tarsal joint twice the second. Hind coxa with 3-4 bristles above the trochanter in a perpendicular row; tibial comb with 16 spines; third and fourth tarsal joints equal.

Abdomen: first tergite posteriorly transversely striate; second to fifth tergites not broadly smooth; the rest of the notopleural surface reticulate, raised and rough on the overlaps and at the edges. Tergite 6 bears on its middle portion a row of 10 bristles and there are 17–19 on the spiracular flap; the seventh tergite bears about 20 bristles; on sternite 5 there is a posterior row of 6–7 bristles, and 24–26 shorter ones in front on each side of the mid line. Free part of sheath nearly half the base.

Length, 1·3 mm.; alar expanse, 2·7 mm.

Type—♀ in British Museum.

Gold Coast: Aburi, 2 ♀♀ ex *Pulvinaria jacksoni*, Newst., 2.ii.16 (*W. H. Patterson*).

Chiloneurus cyanonotus, sp. nov. (figs. 4–6).

Eyes dark chocolate; vertex and frons shining, metallic blue-green throughout the narrowed portion of the frons, i.e., to the point where the orbits begin to diverge; flattened portion of the face down to the blackish mouth-edge semi-transparent, light brown, gleaming, submetallic purplish, at least superiorly; the triangular area below the eye (part gena, part frons), seen in profile, metallic green with a brown tint shining through; occiput brownish, submetallic behind the vertex. Antenna from scape to third funicular joint pale; scape with a slight dorsal and a distinct ventral blackish streak; pedicel with a basal dorsal dark streak; first and second joints of funicle infuscated; third joint lighter, fourth to sixth white; club black. Sterno-pleural surfaces and the axillae for the most part clear transparent brown, with slight infuscation on the mesopleurae superiorly and posteriorly. Pronotum antero-laterally also brownish, non-metallic; metanotum a little darker, dull; pronotum broadly behind and in front, mesonotum broadly in front, and scutellum entirely refringent, showing a play of colour changes in blue and green. Posteriorly the mesonotum is mainly metallic blue, shining in part through silver, the latter effect due to the short white pubescence across the middle of the mesonotum; tegulae brown, darker at the tips. Propodeon dark, a little paler medianly and at the antero-lateral angles in front of the spiracle, with a slightly cupreous gleam. Fore wings a little darker than in *C. afer*, with a small dark spot at the radix; apical edge of the cloud not so rounded as in *C. afer*, more transverse and irregular. Legs transparent yellowish-brown, with a dorsal streak on the fore femora and the dorsal basal half of the mid tibiae infuscated; in the mid legs the femur is quite pale on the basal half and in the hind legs the same contrast appears, though not so definitely. Abdomen nearly black, with dark cupreous reflections.

Head (fig. 4 *b*) as wide as deep; eyes descending two-thirds towards the clypeal edge, which is one-seventh of the width of the head, with the inner orbits subparallel to about one-half. The shortest distance across the frons at one-third down is one-half that at the lateral ocelli, where the breadth is one-sixth of the width of the head, and on the base line approximately three-fourths; the eyes, however, are so gradually rounded off below that the last measurement is difficult to determine. The toruli are extremely far down and far apart, practically at the corners of the mouth-edge, and nearly flanking the clypeus itself; at their widest they are separated by nearly three times (11 : 32) the straight clypeal edge. Whereas in *C. afer* the thickened raised reticulation extends round the orbits to the lowest point and almost to the same level across the lower frons, in the present species such a refringent sculpture is found only on the vertex and to the length of its own diameter in front of the anterior ocellus. The face is nearly smooth, with a slightly raised reticulation mid-way between the toruli and the base of the eyes, the lower orbits, however, being quite smooth; the orbital bristles (13–15) on each side below the ocellus are well developed. Along the mid line, between and a little above the toruli, are 5–6 pairs of bristles, with 3–4 between the lowermost pair of each row and the torulus; 3 stouter bristles above the clypeal edge, and 2–3 between each corner and the torulus; the face is otherwise bare; towards and on the genae the surface becomes striate reticulate, with one or two bristles.

Mouth-parts: labrum minute, concave, 5 (?)–7 (?) bristles, the middle pair longest; mandibles (4 : 3) distinctly tridentate, somewhat narrow apically, the middle tooth more prominent and broad, the uppermost nearly rectangular, 1–2 bristles on the stipes; joints of the maxillary palpus, 5 : 3 : 4 : 6; the first joint about twice, the fourth two and a half times as long as broad.

Antennae (fig. 5 *b*): length, ·68 mm. Scape (5 : 1) just longer than the club, or two and a half times as long as the pedicel, or just shorter than the pedicel and first four funicular joints; pedicel, 5 : 2; funicle: first joint just longer than broad, the others transverse; last funicular not quite half as broad again as the first; club much wider than either the last joint of the funicle (5 : 3) or the first (3 : 1). On the scape there are a few subdorsal bristles on both sides, and on the inside a ventral row (9–10); the bristles of the pedicel and funicle are rather long and stiff. Few sensoria, and only on the last two funicular joints and on the club segments, as follows:—5th, 1–2; 6th, 4–5; (*a*) 6–7; (*b*) 7–8; (*c*) 6.

Thorax: pronotum coarsely raised reticulate on the posterior half, the surface smooth anteriorly; 18–20 bristles in the post-median row, *rising well in advance of the hind margin*; no spiracular emargination. Mesonotum: there are three types of sculpture here, (*a*) anteriorly a narrow refringent area, cells thick-walled, raised; (*b*) a broader belt of longitudinally drawn out, closely aggregated, setigerous cells, the bristles being short and for the most part appressed; and (*c*) before the scutellum a nearly smooth band, with a normal fine slightly raised reticulation, with 4 dense bristles (2 : 2) of which the middle pair are longer. The suture is obtusely angled over the axillae, which bear 3 bristles each; the scutellar tuft of heavy bristles is dense, and there are besides 5–6 normal bristles on each side of the mid line. The pattern of the axillae and scutellum is uniformly raised and thickened, coarser on the scutellum; mesopleurae very finely striate.

Propodeon smooth, reticulate towards the antero-lateral angles, with 3 bristles behind each spiracle towards the mid line.

Wings: fore wings narrower than in *C. afer*, with a longer fringe, nearly three times as long as broad; length (excluding fringe) ·9 mm.; breadth, ·32 mm.; the marginal is shorter than in *C. afer*, the proportions of the veins being approximately 10 : 3 : 1 : 1. Fewer bristles on the submarginal and base of the marginal (6 and 3), while behind the marginal towards the base the heavy bristles stand only 2–3 deep; one rather long bristle at the end of the post-marginal; on the radius stand 2 clear bristles at the base, 3 on the stalk, and 2 at each side towards the stigma (fig. 6 *c*). Hind wings: length, ·75 mm.; breadth, ·18 mm.

Fore legs: coxae (3 : 2) with a median patch of 9–10 minute bristles on the inside; femur (25 : 7) with no ventral row of bristles, but beyond one-half, 6–7 of the subventral row project over the edge; tibia (7 : 2) with the upper apical angle chitinised; one stouter median subapical spinose bristle posteriorly; comb of 7 clear spines anteriorly, and one coloured spine above the apical chitinisation; 12–14 spines in the tarsal comb. *Mid legs*: femur (6 : 1) widest at one-third from the apex; tibia just shorter than the femur, narrowest (1 : 9) at two-fifths before the apex (2 : 9); 6–7 peg-like spines anteriorly at the apex, and a short fine-pointed thin one above the spur, which is longer than the first tarsal joint; joints 1–4 with heavy spines, (*a*) 18–20, (*b* and *c*) 5–6, (*d*) 3. *Hind legs*: tibial comb with 14 bristles; the coxa has one strong bristle above the trochanter, and several short and fine on the anterior outer half. Proportions of the tarsal joints:—

Fore	..	27	15	13	13	20
Mid	..	45	20	15	15	20
Hind	..	35	22	18	15	20

Abdomen mainly smooth dorsally; tergite 2 on the anterior half with a band of thickened raised cells, so loosely connected as to give the impression (medianly at least) of 4–6 rows of irregular punctures. From the extreme sides of this band, and backwards to the tip of the abdomen the upper surface of the tergites is narrowly reticulate; all the tergites are convex posteriorly and the 2nd is straight anteriorly. Sternite 5 bears posteriorly three rows each of 6–7 bristles, and a patch of about 10 in front on each side of the middle line. Free part of the sheath two-fifths of the base.

Length, 1·2 mm.; alar expanse, just over 2 mm.

Type—♀ in the British Museum.

Gold Coast: 2 ♀♀, Aburi, ex *Lecanium* sp. on *Tephrosia vogelii*, 19 . xii . 15 (*W. H. Patterson*).

Genus Cerapterocerus, Westw.

Cerapterocerus, Westwood, Mag. Nat. Hist., vi, 1833, p. 495.

The species now described is similar to that figured by Dr. Masi (Boll. Lab. Zool. Port., iv, 1909, p. 6, fig. 5) under the name *C. corniger*, Walk. (Ent. Mag., v, 1837, p. 114). Dr. Masi's examples, which, as he now agrees with me, are not referable to Walker's species, were bred from *Ceroplastes rusci* at Catanzaro, and again at Portici; they represent a distinct species, which requires a name, if *C. latevittatus*, A. Costa (Atti Accad. Sc. Napoli, ix, pt. 11, 1882, p. 38), is as Dr. Masi suggests

(loc. cit. p. 12) a synonym of *C. mirabilis*, Westw. (loc. cit.). The Italian species, *C. pattersoni*, sp. n., and *C.* (*Eusemion*) *corniger*, Walk., all exhibit the same type of wing pattern, but they can be separated very easily by antennal and other characters.

Cerapterocerus (Eusemion) pattersoni, sp. nov. (fig. 7).

♀. Vertex and frons as far as the flattened portion of the face, thoracic notum (except for a pale postero-median edging to the pronotum, including the scutellum), refringent, metallic deep-green, with a slight play of colour, a little blue on the axillae and sides of the scutellum. Flattened portion of the face above the toruli dull cupreous or purplish; clypeus, genae and lower angles of the frons, and the mid line between the toruli shining metallic blue or violet-black; antennae black with violaceous reflections. Thoracic sternum, propodeon, abdomen and ovipositor nearly black, with violaceous or cupreous reflections. Wings almost entirely clouded,

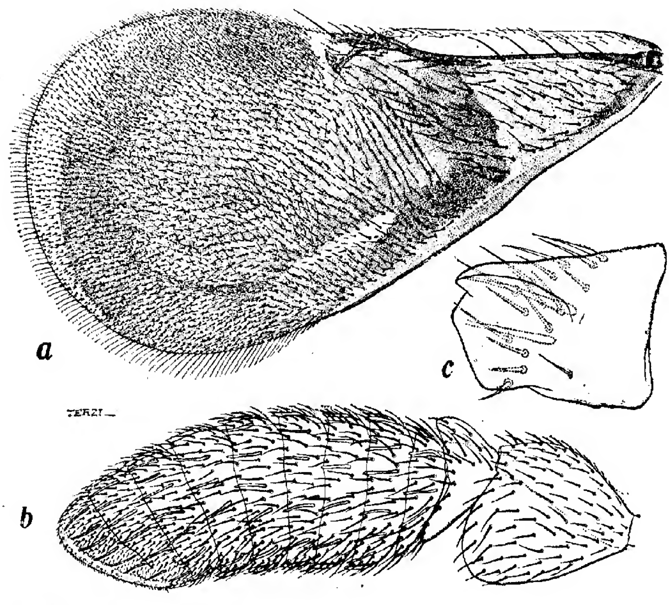

Fig. 7. *Cerapterocerus pattersoni*, sp. n., ♀; (*a*) left forewing; (*b*) right antenna, inner aspect; (*c*) left mandible.

narrowly clear at the apex (fig. 7 *a*); a small faint clouded spot on the hind wings at the hooks. Legs blackish brown. Fore legs: trochanters, knee (narrowly), and apical one-fourth of the tibia obscurely paler. Mid legs: coxae pale on the dorsal (superior) aspect; the tibia becomes increasingly paler towards the apex; spur black; tarsus paler, slightly tinted. Hind legs concolorous to apex of tibia; first tarsal joint blackish on the apical half; joints 2–4 nearly white, the fifth blackish brown; all the claws nearly black.

Head, from in front, wider than deep (23 : 20); eyes reaching downwards barely beyond one-half, separated at the nearest by one-fifth to one-sixth the width of the head, and at the base line by nearly the entire width (five-sixths). Toruli subtriangular, the base of the triangle (dorsal in position) with the upper angles rounded, separated from one another superiorly by twice, and inferiorly from the mouth-edge by once their own length; mouth-opening three-eighths as broad as the head. The refringent vertex and upper frons show the usual fine raised thick-walled reticulation: lower face narrowly smooth along the mid line; genae with fine striae, smooth: the hollows for the scapes occupy nearly all the lower face from in front, and their surface is regular raised-reticulate; between the toruli and above the mouth-edge the pattern is finer. Parallel with the clypeal edge is a row of 5–6 bristles, and above the mouth-edge and to the level of the toruli, as well as between the latter, the surface is densely set with short bristles, of which one or two straggle up the mid line towards the frontal ridge; on the genae are a few stronger bristles, and there are 5–6 before the genal keel, at the edge between the flattened and unflattened surfaces of the lower frontal angles.

Antennae (fig. 7 *b*): length, ·93 mm.; scape as long as the pedicel, first and second joints of the funicle together; or as the club alone; or a little more than half the funicle; ring-joint minute, concealed; the pedicel is remarkably produced below.

Mouth-parts: for the mandibles see fig. 7 *c*; joints of maxillary palpus, 15 : 10 : 14 : 30; 4 of the apical bristles long, one longer than the joint itself.

Thorax. Pronotum: pattern much coarser below the spiracle; posterior row of bristles about 20; sternite and episternite with the same pattern as the overlap: the former with over 30 bristles, chiefly posteriorly. Mesonotum: reticulation of the mid lobe finest and most raised, of the scutellum coarser, and of the axillae least raised; mesonotum entirely covered with short, stiff bristles, 5 on the axillae, about 40 (20 : 20) on the scutellum, with two sensory pustules, very close to one another, behind one-half. Mesopleurae: at the upper anterior angle near the episternite, whose pattern it reproduces, the pleura has a more regular reticulation, which passes quickly into one long-drawn-out, so that with a moderate power (up to × 50) the sides of the thorax appear finely striate throughout their entire length.

Propodeon medianly linear, descending, expanded, with two triangular lateral areas surrounding the rather large oval spiracle, from which 7–9 rugae pass backwards; 3–4 antero-lateral bristles beside the spiracle; postero-laterally the surface is reticulate.

Wings. Fore wings (fig. 7 *a*): a little over twice as long as broad; length, 1·15 mm.; breadth, ·50 mm.; submarginal: marginal: radius: post-marginal, as 40 : 7 : 5 : 3. Twelve bristles on the submarginal vein; 6–7 along the middle of the marginal and 5 (the last much longer) at the edge, on the marginal and post-marginal combined, with numerous shorter ones on the under surface; one long bristle on the radius near the base, and 1–2 on the anterior edge. The clear spot between the post-marginal and radius is nearly bare (1–2 small bristles). Hind wings: length, ·9 mm.; breadth, ·3 mm. The vein lies along the costa, on its basal half, and the cell is nearly obliterated apically; 8–9 bristles on the apical half of the vein, 9 minute bristles above the hooks; discal ciliation regular and leaving only a small basal triangle, within which is an isolated patch of bristles near the vein.

Fore legs: femur (9 : 2) rather bare, a few subdorsal bristles towards the apex anteriorly, and between the apex and lower basal angle a diagonal row of short bristles (about 12); 2 stronger subapical ventral bristles; tibia (30 : 7) three-fourths of femur, narrow at base, 7–8 of the bristles on the dorsal edge much stronger; comb with six spines; first tarsal comb with about 12 spines on the apical half of the joint. *Mid legs*: femur, 6 : 1; tibia (10 : 1) at middleand (7 : 1) at apex, 8 short heavy spines at apex; spur longer than first tarsal joint; tarsal joints with the following heavy spines:—(1) about 20, (2) 6, (3) 5, (4) 4–5, (5) 2–3 thinner than the others. *Hind legs*: coxae nearly as broad as long (15 : 16); tibial comb with 15 spines. In the hind and mid legs the first three tarsal joints are in ratio 9 : 5 : 4; in the forelegs the second and third joints are a very little longer.

Abdomen a little longer than broad (about 5 : 4); projecting sheath of the ovipositor between one-fifth and one-fourth as long as the abdomen; surface broadly smooth medianly on tergites 1–6, the overlaps being distinctly rough; 7th tergite (middle portion) delicately reticulate. On each overlap (tergites 1–4) is a single bristle isolated from the posterior row, which is broadly separated on tergites 1–4 and continuous on 5 and 6; the number of bristles in each half of the row runs from 6 (tergite 1) to 4 (tergite 4); the setigerous process (tergite 7) bears 3 long and 2 short bristles; between and behind the processes are upwards of 30 bristles. Free portion of sheath to base, as 2 : 5. The 5th sternite bears, besides other bristles, 2 widely separated patches of 20 bristles each.

Length, 1¾ mm.; alar expanse, just over 3 mm.

Type—♀ in the British Museum.

GOLD COAST: Aburi, ? 5 ♂♂, 4 ♀♀, ex *Vinsonia personata*, Newst., 23.xii.1915 (*W. H. Patterson*).

Genus EUNOTUS, Walk.

Eunotus, Walker, Ent. Mag., ii, 1834, p. 297.

I have provisionally referred the following species to the genus *Eunotus*, although the smooth first tergite, slightly shorter than in the genotype, and the peculiar wings might justify the erection of a special genus for its reception. It differs obviously and superficially from *E. cretaceus*, Walk. (loc. cit. p. 298), but as the latter is represented in the British Museum collection only by the unique type, I have not felt justified in undertaking a critical examination of the species. Few Eunotine genera and species have as yet been described, but the thorough examination which I have been able to make of the external morphology of the present form entirely supports Dr. Howard's suggestion (The Canadian Entomologist, xxviii, 1896, p. 165), as to the affinities of this most interesting Coccid-destroying group. Ashmead's placing of the sub-tribe (Mem. Carneg. Mus., i, 1904, p. 325) amongst the PTEROMALIDAE seems to me quite inadmissible.

Eunotus truncatipennis, sp. nov. (figs. 8, 9).

♀. Shining black, with faintly tinted wings; on the occiput (more dully) and abdomen dark sub-cupreous; on the notal surfaces a trace of deep blue. Antennae light reddish-brown, the pedicel darker above. Presternum, pre-episternites and sides of the pronotum pale. Legs: fore coxae (except at the inner basal angle, which is pale), mid coxae entirely, hind coxae from base to apex on dorsal half, all the

trochanters and femora, blackish-brown: hind coxae pale on the ventral half, the colour contrast between the upper and lower halves sharp, though the boundaries of the tints are not well-defined; all the tibiae fuscous, lighter than the femora; in all the tarsi the first and fifth joints are embrowned, while the second and third are paler and more yellow in tone. In some specimens the tibiae are not quite uniformly coloured, there being a tendency for the dorsal and ventral edges to be darker streaked.

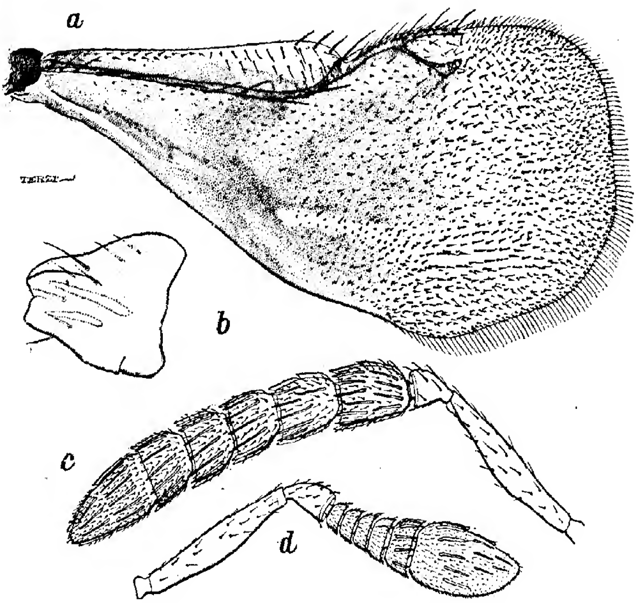

Fig. 8. *Eunotus truncatipennis*, sp. n.; (*a*) right forewing, ♀; (*b*) left mandible, ♀; (*c*) antenna, ♂; (*d*) antenna, ♀.

Head, from in front, much wider than deep (7 : 4), triangular, concave across the vertex, and truncate below, much narrower at the mouth-edge, which is only five-sevenths of the distance between the eyes at their nearest. The eyes are, in profile, two-thirds the depth of the head, prominent and rounded, angular ventrally, and absolutely bare; toruli very small, and barely over their own length from the mouth-edge. The reticulation of the surface consists of irregular hexagonal cells on and below the vertex; further down, the cells are quadrate or pentagonal, transversely and ventrally drawn out; the smallest cells occur between the toruli. The face is bare from above the toruli to the middle; the orbits bear numerous minute bristles, and there are a few more on the frontal surface, chiefly above; about a dozen short bristles in two ventral rows between the toruli, and 3–4 below each; 4 longer bristles on the clypeus.

Mouth-parts: labrum long, with 6–7 bristles on upper distal edge and 2–3 below medianly; mandibles (fig. 8 *b*) short, thick, triangular, bidentate; stipes with a coarse scaly reticulation, the transverse walls of the cells distinctly raised, the others faint; one bristle behind the palpus; two (minute) at the sides. Palpus, 6 : 11 : 9 : 23, measured along the outside edge, with a width of 8 on the fourth joint; joints 1 and 2 bare; one minute bristle opposite the insertion of the palpus; mentum with 7 bristles; labial palpus, 9 : 7 : 15, with a uniform width of 7. Antennae (fig. 8 *d*) 9-jointed; scape, pedicel, ring-joint, five in funicle, and solid club; length, ·5 mm.; bulla minute; scape (5 : 1) spindle-shaped, broadest medianly, longer than the pedicel and funicle combined, and one-half as long again as the club; all the funicular joints are transverse, and the widths of the first funicular, the fifth funicular and the club are in the ratio 3 : 6 : 7. Sensoria: fourth funicular, 1–2; fifth, 5–6; club, three rows of 8, 7, 5; between these rows there is a dorsal thickening of the chitin which may be the vestiges of the original sutures of the club segments.

Thorax dorsally flat and level. Prothorax more weakly chitinised on its lateral angles, where the pattern becomes faint and transverse; about 12 bristles in the posterior row, and 2–3 minute ones in front of the stigma; over 20 minute scattered bristles on each side of the mid line. The pronotum appears superiorly only as a narrow anterior edge to the mesonotum; the greater part of the sclerite being perpendicular; presternum transverse, diamond-shaped, and thinly chitinised. Mesonotum with the parapsidal furrows thick, meeting the suture *inside* the lateral angle of the axillae; the suture very straight; abscissa of the axillae to the abscissa of the parapsidal furrows, as 17 : 15. The scutellum is broader than long (13 : 11) and longer than the mid lobe (21 : 17), whose length (four-sevenths of its breadth) equals exactly the distance between the axillae. The thorax is particularly heavily chitinised, and the reticulation seems to be worked into the integument rather than to lie superficially; the notal surface is fairly smooth, except on the scutellum, where the pattern is raised, chiefly longitudinally, so that 8–10 short heavy striae appear behind the suture; the pattern is rather fine on the pronotum, side lobes and axillae, and about equally coarse on the mid lobe and scutellum. The mid lobe bears 30–40 minute bristles, the side lobes 9, the axillae about the same; scutellum with about 10 bristles on the disc on each side of the mid line, with a marginal row of about 12 stronger ones above the metanotum, of which 3–4 on each side of the apex rise from distinct punctures. Prepectus small, triangular, and smooth; there is a sharp edge (a false suture) between the ventral and pleural parts of the sternite; the former, owing to the backward displacement of the presternal parts, lies considerably in front of the latter for one-third of its length, the prepectus being thus somewhat isolated. The sternum ventrally is trapezoidal, with a regular, bold, but not very large pattern; 4–5 bristles on each side postero-laterally, and a large hyaline spot at the posterior end of the well-defined middle ridge; episternite small and smooth; the pleurae somewhat flat and elongate, divided indefinitely into an upper (epimeral) and a lower (sternal) portion. The anterior half of the epimeron is nearly smooth, while a large striate reticulation covers the rest of the sclerites; the epimeron is produced into a minute but decided tooth at one-third its length, above the coxa. Metanotum and propodeon together, broad and short, markedly declivous about the mid-line; post-scutellum lying below the posterior edge of the scutellum, not carinate, but ridged

and divided into two, so that the metanotum appears to consist, on each side, of two smooth sunken lateral narrow sclerites; on the propodeon are five carinae (one median, one before and one outside each spiracle) of which the median is extremely short; that before the spiracle descends abruptly on the inner side, while the surface falls more gently outwards. Beyond the spiracle the surface rises gently, then falls perpendicularly to the sternum, thus forming the second lateral keel; viewed from above, both lateral keels project backwards like teeth, and the outer one curves a little outwards as well. The space between the short inner keel and the first lateral one is transversely divided into (*a*) an anterior triangular area crossed by 5-6 short keels, the surface between these little keels being finely rugulose, and (*b*) a posterior descending oblong bifoveolate area; these two pits are generally difficult to see, owing to the rotund first abdominal tergite. The spiracle which lies just anterior to the middle of the area between the lateral keels can with difficulty be made out in an ordinary dry-mounted specimen. The tracheal opening moderate-sized, circular, a little flattened on both sides postero-laterally, and over-arched by a thin operculum of chitin, the actual opening to the air being a narrow convex slit facing the outside of the first lateral keel; inside the second keel are 5-6 bristles, with 8-9 just outside below. The metapleurae are ridged perpendicularly in front of the coxae, the ridge being interrupted below the postero-lateral angle of the propodeon, thus forming a small tooth or projection above the coxae (cf. the mesopleurae).

Wings. Fore wings (fig. 8 *a*) remarkable for their truncated appearance and the costal notch at the end of the submarginal cell; two and a half times as long as broad; length, ·98 mm.; breadth, ·4 mm.; submarginal: marginal: radius: postmarginal, as 38 : 9 : 7 : 7. The shape of the wing and the very faint tinting are shown in the figure, but to give the general effect it has been necessary to show the chaetotaxy of both sides of the membrane simultaneously. It should be noted that all the bristles in the submarginal cell rise *below*, even the 3 stouter ones at the apex. The submarginal vein bears 9 bristles, and there is a tenth, very stout, at the junction of this vein with the marginal, situated on a curved knob; at the edge of the marginal and submarginal combined are about 12 pairs of unequal bristles, one directed upwards and the other outwards and downwards: otherwise the marginal, post-marginal and radius are absolutely bare superiorly, but below there are 4-5 bristles nearly at the edge parallel to the post-marginal; of these, one commonly appears through the base of the radius.

Fore legs: coxae about 2 : 1, pattern coarse and transverse: in addition to numerous smaller bristles all over the surface, there are 4-5 longer ones rising from the base to the broad apical flange. Femur (11 : 4) broadest beyond one-half from the base, with numerous short bristles, 2-3 deep, antero-ventrally. Tibia (4 : 1) with a median chitinous knob at the apex between the spur and the tarsus; the usual comb is reduced to 3-4 colourless, antero-ventral spines; at the apical angle anteriorly are 3 coloured spines, and there are 3 similar postero-ventrally. The first tarsal joint is peculiar, as the comb (about 20 fine spines) is entirely on the plantar aspect, flanked on both edges by 5-6 bristles; 2 bristles or spines on the base of the tarsal ungues. *Mid legs*: coxa, 4 : 3; femur (4 : 1) of the same length as the fore femur, and, like it, with numerous ventral bristles; tibia (23 : 4) with 3 spines both anteriorly and posteriorly on the ventral half at the apex, the anterior more widely spaced;

the spur not three-fourths of the first tarsal joint. *Hind legs*: coxae (2 : 1) pear-shaped, smooth on the inner aspect and externally on the ventral half, and with a coarse, long drawn out, raised pattern above; on the inner aspect are numerous short bristles, except on the basal ventral half, and externally there are 7–8 short bristles below the middle of the mid line; dorsally there is a remarkable clump of long bristles, the upper ones curving downwards and the lower ones curving upwards at the end, forming a distinct brush. Femur a little over three times as long as broad, and, like the fore femur, widest beyond one-half from the base. Tibia (20 : 3) as long as the femur, with 2 apical spurs; on each side, above the smaller of these spurs there stands, on the anterior apical edge, a short spinose bristle, and there are 1–2 more at the upper apical angle; the posterior comb consists of 14–15 spines. Besides the bristles at the base of the tarsal ungues there is a short knob or angle between the base and the claw on the inner aspect. Proportions of tarsal joints:—

Fore legs	11	5	4	3	7
Mid and hind legs ..	18	7	5	4	7

Abdomen: first tergite covering about three-fourths of the notal surface, perfectly smooth, with large overlaps, nearly bare, except for a patch of antero-lateral bristles, practically all on the overlap. Second tergite with 2–3 minute bristles at the extreme edge, above the overlap; tergite 3, like 2, but with a complete post-median row of bristles (16–18); tergite 4 has 8–10 small bristles above the overlap and 2–3 below; on tergite 5 the bristles at the sides and on the overlap are more numerous; tergite 6 posteriorly concave, with (when flattened out) distinct postero-lateral angles, anteriorly deeply concave and produced at the sides into two broad lobes. Spiracle at the side, facing posteriorly, with a patch of about 10 bristles behind and towards the mid line; upwards of a dozen bristles between the setigerous processes. The ovipositor is longer than its sheath, the exposed portion greatly exceeding the free part of the latter, which is about one-sixth of the base. Sternites 1–4 gently concave posteriorly, the fifth long, sharply-pointed; the first not quite half (8 : 17) of the ventral surface and bearing two basal lateral oval perforations; the fifth (7 : 5) is shaped like the gable-end of a house, the base broad (2 : 1) and shorter than the gable (3 : 5).

Length, nearly 1½ m; alar expanse, 2½ mm.

♂. Like the ♀, but the wings hyaline and the antennae infuscated. The legs are darker, the hind coxae being dark above, infuscated below, and pale at the base ventrally; the tibiae are darker, paler apically, where they are coconlorous with the first tarsal joint.

Antennae (fig. 8 *c*): length, ·72 mm.; scape and pedicel, ring-joint, four in funicle, three in club; the funicle is cylindrical, and the joints diminish in length; the stalks are short and distinct, and the sensoria much raised, long and numerous; in the maxillary palpus the fourth joint is longer than in the ♀ (26 : 23). *Wings*: length, ·94 mm.; breadth, ·42 mm.; a little broader than in the ♀, but essentially the same, and as in the ♀, the radius bare and the marginal and post marginal with only the major fringing bristles. *Propodeon* narrower than in the ♀, descending more abruptly between the inner and outer lateral keels; spiracle more oval. *Legs* as in

the ♀, but the brush on the dorsum of the hind coxae is much sparser; tarsal ratios as in the ♀, but the first joint of the mid tarsus is nearer 17 than 18, and that of the hind tarsus is 16.

Length, nearly $1\frac{1}{4}$ mm.; alar expanse, over 2 mm.

Type—♀ in the British Museum.

GOLD COAST: Aburi, 3 ♂♂, 6 ♀♀, ex *Lecanium ? somereni*, Newst., on Kola, 23.xii.1915 (*W. H. Patterson*).

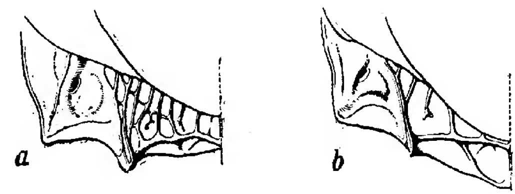

Fig. 9. Left half of the dorsal surface of the propodeon of (*a*) *Eunotus truncatipennis*, sp. n., ♀; (*b*) an allied species from the Seychelles.

Note.

Just before going to press I have had an opportunity, through the kindness of Dr. C. J. Gahan, Keeper of the Dept. of Entomology, British Museum (Natural History), of examining the collection of Chalcidoidea made by the Percy Sladen Trust Expedition to the Seychelles, and worked out by Dr. Luigi Masi of Genoa, whose report is shortly to appear. There is in this collection a form close to *E. truncatipennis* for which Dr. Masi proposes to make a new genus (*cf. supra* p. 252). In general appearance the West African and the Seychelles forms closely resemble one another, but the latter insect has some minute bristles on the radius and on the marginal and post-marginal in addition to the stouter bristles fringing the latter veins. The propodeon, too (fig. 9 *b*) is flatter (the area between the mid and first lateral comb being hardly higher than the spiracular area) and on each side slopes towards the mid line, instead of being almost perpendicular to it; the "teeth" are also less prominent. More material is required to determine the status of these forms. Owing to the excessive smoothness of part of the integument and the black or blue-black coloration, the sculpture of these insects is difficult to make out.

NOTES ON BLOOD-SUCKING FLIES IN GRENADA.

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(Plates III & IV.)

Grenada is the southernmost of the string of Islands composing the Lesser Antilles, if we except Trinidad and Tobago, some ninety odd miles further south, which lie close to the South American mainland of Venezuela. Geologically the Island is volcanic; basalts, lavas, cinder beds, gravel beds, agglomerates, various earths or clays forming the soil and subsoil of valleys, slopes, ridges, cones and craters, from sea-level to some 3,000 feet of elevation.

The Island is clothed in vegetation; rather scanty bush for varying distances by the sea margin, natural forest on the higher ridges, and a carpet of dense cacao and fruit-tree growth on the main part of the land. The mountain ridges are central, the cultivation zone surrounding them and extending to the sea, except where the margin of scrub stretches for varying widths along the littoral.

The ground rises from the sea rapidly, and the population with the exception of those living in the few small coast towns, about one-sixth of the whole live by agriculture in the cultivation zone at elevations roughly between 300 and 1,500 feet. There are of course some dwellers by the sea and some small holders higher in the mountains; and the Island may be considered to be inhabited all over, though to the ordinary traveller the forest heights are not too smoothly accessible.

Meterologically, it may be remarked in brief that the temperature is equable, and a mean of 80° may be accepted for the whole year with little variation and trifling range. The rainfall, though more concentrated in the June and November periods, is well distributed throughout the year, and while there is no disconcerting humidity, and the Trades blow ever fresh from the East, the combined effect of rainfall and vegetation is to maintain moist subarboreal conditions.

Owing to the nature of the cultivation (arboreal in the main) and the climate, the natural life of the cultivation zone differs little from that of the forest zone; elevation and the scattered presence of man causing the chief difference. The significance of this fact may be observed in these notes: and another example of it is seen in the habits of the monkeys (*Cercopithecus mona*), which live in the forest ranges, but regularly come down to quite low elevations to regale themselves on the growing cacao-pods, bananas, etc. Among mosquitos, *Limatus durhami* seems as happy breeding in a broken bottle under cacao a few hundred feet above sea-level as in a palm-leaf petiole in the mountain forest at 2,600 feet.

For the identification of the insects here considered I am indebted to the Wellcome Bureau of Scientific Research, whose Director-in-Chief, Dr. Andrew Balfour, C.M.G., has given me much other scientific assistance during my stay in the West Indies. Mr. Malcolm MacGregor, Entomologist to the Bureau, as well as making many of the

identifications, has assisted me in many ways and tried his best to make an Entomologist of me. I am also indebted to Mr. F. W. Edwards, of the British Museum (Natural History), for having identified mosquitos referred to him by Mr. MacGregor, and among these Mr. Edwards has described one of the new species mentioned in this paper.

The only Anopheline found has been *Anopheles argyrotarsis*, R. D., a recognised malaria-carrier. Its permanent habitat in Grenada lies in the shallow moist flats in the neighbourhood of lagoons and estuarine swamps around the coast of the whole Island. Individually these spots are of no great dimensions; many are remote from human habitations, and effort properly directed should be able to abolish the breeding places at little cost.

The temporary breeding places are unfortunately scattered throughout the Island in intimate contact with the residences of the human population. Chiefly in the wayside gutters along highways and byways, and in hoof-marks, pig-wallows, trenches, and flats in grass land and elsewhere are these temporary breeding places to be found.

The streams are mostly brawling torrents rushing rapidly to the sea in narrow boulder beds, for the most part shaded by cacao and forest growth, and in general are exempt from malarial indictment. When the waters are low, ideal algae-growing Anopheline breeding pools are formed and in the streams of the nature described, but running through open scrub land in the coast belt, where the sun can beat all day, Anophelines will breed (Pl. iii, fig. 1).

Under the shade of cacao, and elsewhere in shade, I have repeatedly examined seemingly ideal Anopheline pools without finding any trace of the existence of these mosquitos. *A. argyrotarsis* loves pools on which the sun will shine most of the day, and the larvae are to be seen in these in great numbers, tangled in algae, more frequently on the shaded side of the sun-heated pool; but they avoid pools where there is any excess of overhead shade.

The well-grown larvae hatch out readily in captivity, but whether kept in sun or shade the younger larvae tend to die off.

The mature insects of both sexes feed greedily on sugar and syrup. Their bellies can be seen distended to look like pearls, and in default of a meal of blood the syrup helps to make them more presentable when pinned out as specimens. The captive female feeds readily on blood at any hour of the day.

Stegomyia fasciata, F., is the common domestic mosquito and is frequent in the usual infinitude of receptacles in and about house and yard in the town of St. George's, and no doubt in the other towns and villages of the Island.

In the country districts *Stegomyia fasciata* is not so common. Only twice out of many searchings have I found the larvae about native dwellings in the country, once in a wooden barrel and again in an earthenware jar. For three months also at my own residence, at an elevation of 800 feet, surrounded by cacao and fruit trees and within a few hundred yards of native cottages, I set traps in vain for *Stegomyia*. Afterwards, however, they arrived and could be obtained in abundance in stray vessels set about the house and at the edge of the cacao plantations.

Never did I find the larvae in the empty cacao pods which are the common breeding place of *Limatus durhami*. I have found them in rock-holes (containing rain-water)

by the sea, about one hundred yards from my office and about the same distance from the Yaws Hospital. Once have I found *Stegomyia* larvae in a wild pine, in which also were larvae of *Wyeomyia pertinens*.

The houses of the people throughout the Island are for the most part closely surrounded by arboreal growth, which possibly is inimical to the existence of *Stegomyia*. The larvae also are a very sweet morsel to *Megarrhinus* larvae in captivity, and probably if a benighted *Stegomyia* lays her eggs in the tree-holes and wild pines frequented by the *Megarrhinus* the larvae will have little chance of reaching maturity.

Thus, in Grenada, the control of *Stegomyia fasciata* is mainly a matter of efficient sanitary administration in the towns; and domestic care in the country should meet with ready success in eradicating this mosquito.

The imagines of both sexes readily gorge themselves on sugar and syrup, which they prefer to fruits. Fertilisation takes place in captivity; and once, on pinning out a female after being chloroformed, a dozen eggs were spasmodically ejected: several reached the floor, while seven were caught stuck together, end to end. When feeding some Anophelines on blood, this and other *Stegomyiae* were along with them, and she may have tasted blood, though not observed to do so. I have not otherwise succeeded in getting captive *Stegomyia* to suck blood, and believe this fertilisation followed on sugar feeding alone. I have attempted to repeat the experiment, but without success. *Stegomyia fasciata* certainly bites by day, and no doubt also in the dark.

Culex fatigans, Wied., is found in wayside pools and ditches, and more certainly if these are foul. I have captured numbers of insects in a pit closet privy, the pit of which was open to the entrance of rain-water, and have secured abundant larvae also from an unprotected pit used for the deposit of human excreta, which was flooded with storm-water.

Filariasis in an acute form is not known at present in Grenada, though several atients with morbid conditions diagnosed as filariasis have been reported, who nay previously have acquired infection elsewhere. In about a thousand bloodmears examined for relative blood count and for malaria, no filaria has been disovered, and examination of the blood of several suspected filariasis cases has revealed ione.

Limatus durhami, Theo., is perhaps the most ubiquitous mosquito in Grenada. Its larvae may be found readily from an elevation of four hundred feet—and probably as low as the cacao extends—usually in old cacao pods, and in fallen palm-leaf petioles and in the flower spathes of palms in the forest at 2,300 feet elevation. I have also found larvae just within the edge of cacao growth near the kitchen door of my residence, in a broken bottle, a typical *Stegomyia* receptacle.

The larvae are not unlike those of *Stegomyia fasciata* and hang almost vertically in the water; they move about up and down with a gentle motion and not with the excited complete wriggle of *S. fasciata*. They hatch out readily in captivity, and the imagines feed on sugar and syrup. The insect in nature bites in the day time; I have caught a gorged female on the arm of a maid in the house at 1 p.m., and have seen one trying to feed on my own bare arm under the full midday sun in the plantation.

The colouring of the fresh specimen, with its purple and gold and fleur-de-lys pattern on the thorax, makes it a lovely object. In the forest also, in partial shade, I have seen hundreds of them, male and female, round my legs; and their manner of flight as they gracefully circle and rise and fall, showing apparently four gold-tipped toes as torches tipping a whorl, is a pretty picture difficult to put in the eye of one who has not seen it.

I have made no attempt to investigate the potential malignancy of *Limatus*. The distribution of malaria coincides satisfactorily with the Anopheline distribution, and no other morbid condition is obviously suggested as having any particular relation to this species.

Haemagogus splendens, Will., is fairly well distributed throughout the wooded parts of the Island, practically everywhere except along the sea margin. I have not found it in the forest, but it is commonly reported in the highest cacao growth.

This brilliant blue and green mosquito, with metallic lustre, appears in the house regularly from ten to about one o'clock; between eleven and twelve it is almost certain to be found, if the species is about. I have obtained none but females, and search for the breeding place was long in vain. Ultimately I was rewarded by having one female hatch out from water obtained from a tree-hole, in which also were larvae of a *Megarrhinus* and of *Wyeomyia grenadensis*, the tree being a Walnut or Candle Nut tree (*Aleurites triloba*).

Haemagogus splendens, in common with *Limatus durhami*, *Megarrhinus*, and I believe other brilliantly coloured mosquitos, shows the interesting association of bright colouring with daylight feeding habits, in conjunction with a breeding place in dark vegetable-stained water in black tree-holes. It may be remarked, however, that for a few hours of the day the sun shines directly on some part of the surface of the water in the tree-holes where larvae have been found, so long as the water is maintained at a certain level.

The appearance in the house of *Haemagogus splendens* was at uncertain intervals, long and short, and always seemed to coincide with a fortnight to three weeks after fair rain succeeding drought.

The tree most commonly bearing holes containing mosquito larvae is the Avocado or Alligator Pear (*Persea gratissima*), which grows to perfection in Grenada; the trees, however, seem very frequently to lose their lower branches and, instead of a callus forming, a hole eats into the tree, which collects rain-water and forms a breeding place for a variety of insects and other creatures (Pl. iv, fig. 1).

I trust the loveliness of the *Haemogogus* will spare it from the accusation of being a disease-bearer.

Having obtained only one specimen in larval or pupal state, I have not been able to secure examples for description. The pupa I can only say looked, in size and dark colouring, like that of *Wyeomyia grenadensis*, from among which the imago hatched out.

Wyeomyia grenadensis, Edw., is of interest as being a new species. It comes into the house after dark, and many specimens were caught on one's clothing in the lamp light. The larvae and pupae have been collected from tree-holes and from wild pines. The pupae and larger larvae develop satisfactorily in captivity, but the smaller larvae may remain for weeks without growing or pupating.

Wyeomyia pertinens, Will., is also a gentle visitor of the after-dinner reading hour. The tree-hole and wild pine are its breeding places.

Culex similis, Theo., *Deinocerites cancer*, Theo., *Janthinosoma posticata*, Wied., and *Culex inflictus*, Theo., have been found in the same or similar roadside gutters. The full-grown larvae of all readily hatched out.

Culex inflictus has been caught also frequently in the house after dark. From the distance of my residence from pools likely to harbour its larvae, and from the fact of the only other evening visitors being tree-hole and wild pine breeders, it is possible that *C. inflictus* may also breed in similar situations.

Janthinosoma neoapicalis, Theo., is a handsome insect and has a graceful larva, with a long syphon tube. It is found in the same shallow waters in which *Anopheles argyrotarsis* occurs, the two living freely together. The full-grown larvae hatch out readily, though the smaller ones may remain alive for many weeks in captivity without growing or pupating.

Culex annulatus was found in a shallow well along with *Anopheles argyrotarsis.*

Stegomyia busckii, Coq., was found in a collection of water in the petiole of a fallen palm leaf in the Grand Etang forest, at an elevation of about 2,600 feet; also in a cacao-pod at the upper limits of cultivation. Pupae and well-grown larvae hatch out readily in captivity, but the immature larvae remain for weeks without pupating.

Larvae and pupae of another *Aëdes*, not identified at the time of writing, and probably a new species, were collected from a tree-hole and from a wild pine in a cacao plantation.

Megarrhinus haitiensis, D. & K. The larvae and pupae have been found in wild pines and in tree-holes. This beautifully coloured and lustrous mosquito occasionally visits the house in the day-time, but has not been seen to approach people.

Pupae and well-grown larvae hatch out in captivity, but smaller larvae have not been successfully induced to grow. Even larvae of seemingly full size live for months without pupating. I fed one large larva intermittently during nearly four months on *Stegomyia* larvae. It would devour five larvae in a day and take about a week to eat up about twelve more. It would then go for some weeks apparently without food and repeat the same feat of consumption when supplied with more *Stegomyia* larvae.

At first big and small *Megarrhinus* larvae seemed to live in peace with each other, though even the small ones would voraciously attack by the head and suck *Stegomyia* larvae as large as themselves. After submitting to a period of apparent starvation a four-months-old larva, I placed two other *Megarrhinus* larvae in the bottle along with it, one a small larva and the other almost as large as the old one. The smaller one disappeared very soon, and next day the other was found dead with its head mutilated. After that I dropped the ancient warrior into boiling water to preserve him.

These larvae probably were not those of *Megarrhinus haitiensis*, but of another species, several specimens of which have been preserved but not yet identified. They also were collected as larvae and pupae from a tree-hole and from wild pines.

The large egg of *Megarrhinus* is interesting; looking down into a tree-hole the ova are seen floating on the surface of the water, singly or, more commonly, several are seen together around the edge.

Culex (*Micraëdes*) *conservator*, D. & K., has been found with *Corethrella appendiculata*, Grab., in tree-holes and in wild pines, and from a wayside pool a *Culex* (*Micraëdes*) allied to *elevator*, D. & K., was bred.

Ochlerotatus niger, Giles, is the swamp mosquito of Grenada. In brackish water in the lagoons at Morne Rouge the larvae may be seen in great masses, chiefly in the summer rainy season; and at the same time the mosquitos swarm around these swamps, keeping under the shade of mangrove and manchioneal in the bright daylight, spreading abroad an hour or more before sunset and biting also at night. They would appear to fly for miles and are generally taken for *Stegomyia* by the partially initiated who are troubled by them in town several miles from these swamps.

Deinocerites cancer, Theo., breeds in brackish water in the crab-holes around the lagoons and, as stated above, it has also been found in wayside ditches; but these were probably connected with surrounding crab-holes. On rare occasions the larvae of *Ochlerotatus niger* are also found in the crab-holes nearest the lagoon.

The most disturbing insect in the Island is a *Ceratopogon*, the "sandfly" of Grenada. It is practically ubiquitous, being probably more frequent in spring and autumn, and is peculiarly partial in swarming. Whereas in some places a few may be seen, morning and evening, sometimes throughout the day, and inside the mosquito net when one wakes; at other places, on the contrary, the insect appears in swarms, the morning hour at the breakfast table being the time for doing most business. Each person at table will have a cloudy following, and in the country the frequent déshabillé of the early cup of coffee results, if no precautions are taken, in a liberal distribution of spottiness over all exposed parts. The bite resembles that of the flea, a central dark spot with a pink areola (in Jamaica the areola around the puncture of the common *Ceratopogon* was often a beautiful purple), and on the ankles of one not over sensitive they may be confluent over a wide area.

There is no morbid condition attributed to these creatures, and it is well if none arises, for where they swarm their control would appear to be difficult, especially as the sixteen-mesh netting does not keep them out.

They are said to be more common in the neighbourhood of old masonry and ruined buildings, but I find that the more frequent constant factor is moisture - proximity to cacao festooned with parasitic growth and for the most part of the year dripping wet. Streams also have been in the near neighbourhood of the residences where I have observed the greatest swarming. They are present, however, in dry situations.

Of blood-sucking flies that attack domestic animals, *Stomoxys* is about as common as in England, while TABANIDAE are not common. I have captured a few of the latter (not identified) and always in remote parts where one would think an equine was rarely to be found. I had the same experience in Jamaica, where, though no doubt TABANIDAE are general, I found them chiefly in remote parts, *e.g.*, on the top of St. Catherine's Peak, at some 5,000 feet elevation, where horse flesh and humanity ascended but at infrequent times.

Fig. 1. Boulder stream in Grenada which is exposed to the sun and swarms with Anopheline larvæ after flooding.

Fig. 2. Silk Cotton Tree (*Eriodendron anfractuosum*) in flower, showing numerous parasitic "Wild Pines," in which the larvæ of five different species of mosquitos were found.

Fig. 1. Hole in an Avocado Pear Tree in which *Wyeomyia grenadensis* was breeding. In the fork of the tree is an ants' nest.

Fig. 2. Artificial hole in a Mango Tree, forming a breeding place for *Megarhinus*.

SARCOPHAGA FROGGATTI, SP. N.—A NEW SHEEP-MAGGOT FLY.

By FRANK H. TAYLOR, F.E.S.,

The Australian Institute of Tropical Medicine.

Some two years ago Mr. E. V. Hines, of Winton, Queensland, sent me some fly-maggots which were attacking the sheep on his station. On breeding them out it was seen that they were referable to two different genera—*Pycnosoma* and *Sarcophaga.*

Specimens were later submitted to Mr. E. E. Austen, of the British Museum (Nat. Hist.), who informed me that they were *Pycnosoma rufifacies* (Macq.) and a *Sarcophaga* which was probably a new species.

I take this opportunity of extending my cordial thanks to Mr. Austen for his kindly assistance.

Sarcophaga froggatti, sp. nov.

Length, ♂ 8–9, ♀ 7–8; width of head, ♂ 2·5–2·75, ♀ 2–3; length of wing, ♂ 6–7, ♀ 5·5–6·25 mm.

A small species, with bright creamy-yellow front and face; thorax grey, with three black stripes; abdomen silvery grey, with black irregular blotches; legs black, femora with grey tomentum.

♂. *Head*: front with a dark chocolate stripe, with numerous stout black hairs on its sides bordered with bright creamy-yellow; cheeks bright creamy-yellow; beard pale creamy; antennae and palpi black; proboscis dark chocolate; eyes black with a coppery tinge. *Thorax* grey, pale creamy on the sides, pubescence black, erect, short, with three black stripes, the median one extending to the apex of the scutellum, the lateral ones not quite reaching the base of the scutellum; there are three black prescutellar bristles on each side; pleurae grey; scutellum grey, with six black posterior bristles, the two median ones short. *Abdomen* grey, with numerous black, irregular blotches, densely clothed with black depressed pubescence; apex with eight stout, fairly long spines; venter grey, with pale pubescence, except at the apex where it is black. *Legs* black, femora grey, the front pair stouter than the others. *Wings* hyaline, veins black, squamae creamy.

♀. Similar to the ♂, but the abdomen shorter, broader and more globose.

QUEENSLAND: Winton (*E. V. Hines*).

Described from specimens bred from larvae. In general appearance it is very similar to *S. misera*, Walker, but much smaller and less stout in build.

Type-specimens in the Institute collection.

SOLUBILITY OF THE SCALE OF LEPIDOSAPHES ULMI, LINN.

By S. Maulik, B.A. (Cantab.), F.E.S.,

Imperial College of Science and Technology, London.

The object of this short communication is to state the result of an enquiry into the solubility of the incrustation of the mussel scale-insect which is destructive to the bark of various cultivated trees, particularly of the apple tree. The control of this pest by means of insecticides to a large extent depends upon getting access to the insect by dissolving the scale with which it covers itself soon after it settles down on the bark for the rest of its life. Whatever may be the development of the insect, unless the scale can be dissolved, at least at its point of contact with the bark, no great result can be expected from the application of insecticides.

Experimental.

It is generally believed that the incrustation is of a waxy nature. I therefore used the reagents mentioned below to see if a suitable solvent could be found. For these tests the scales were collected from the bark by picking them one by one with a pair of forceps. In this way a sufficient quantity was collected for the purposes of chemical examination. The scales were mechanically separated from the cast skins, etc., by shaking them in a small tube and then sifting them. By this method a sufficient degree of purity was obtained so as not to vitiate the result of the action of the reagents on the scales.

Reagents used.

The following seventeen substances were tested:—Petroleum ether, benzene, alcohol, xylol, chloroform, acetone, toluene, methyl alcohol, carbon bisulphide, methylated ether, carbon tetrachloride, petroleum, terpineol, clove oil, ethyl acetate, pyridine and soap solution.

The scales were kept in these reagents for nearly a year, but no action seems to have taken place; at any rate, the scales were not dissolved.

Some of the properties of the scale, so far I have been able to find out, are as follows:

(1). It is not dissolved by concentrated sulphuric acid.

(2). It is not dissolved by sodium carbonate, even if heated.

(3). It is hygroscopic, losing 8 to 9 per cent. in weight when heated in a water bath.

(4). It contains about 4·5 per cent. of nitrogen. The nitrogen content was estimated by the Kjeldahl method.

(5). It dissolves in normal solution of caustic soda or potash.

Although caustic alkali dissolves the scale in the test-tube, its application as a spraying fluid is not quite successful, as has been ascertained by me from experiments on trees in the Acton Lodge Orchard. I applied caustic potash solution in various

strengths on the trees with the usual checks, etc. None of them entirely prevented the insects from hatching out. Besides, the application of caustic alkali is beset with mechanical difficulties and causes much inconvenience to the operators.

The treatment in vogue at the present day consists in using either of the three washes, viz. :—(1) caustic alkali wash, (2) paraffin emulsion, or (3) the Woburn wash. The ingredients composing these spraying fluids are caustic soda, lime, paraffin, iron sulphate and copper sulphate. Treating the scale in the test-tube with the above reagents separately, as well as in their combinations forming the washes, it is found that they have no solvent action, except caustic soda. It is on record that these washes have been found useful to a certain extent. This may be attributed to the purely physical action of the paraffin owing to its low surface tension. This property enables the oil to penetrate minute cracks and crevices, thus wetting the surface well. Insects hatching out and coming into contact with the oil are killed.

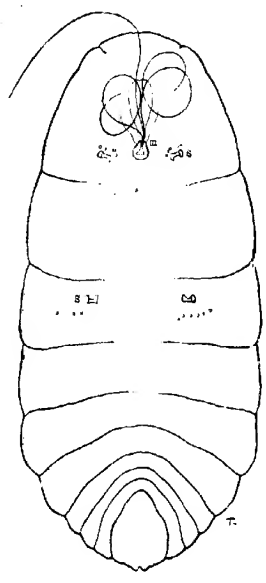

Fig. 1. Lower surface of *Lepidosaphes ulmi*, L. ; *m*, mouth ; *s*, spiracles.

The paraffin may also get access to the eggs by penetrating under the scale where its contact with the bark has been loosened by weather conditions. If in this way the eggs under the scale become thoroughly soaked with the oil it is very improbable that they will hatch. On the other hand, the chances of the oil thoroughly wetting a whole batch of eggs under the scale are very remote. Thus we find that even after a good spray a large percentage of insects hatch out.

The Spiracles of the Insect.

It is a generally accepted view that contact insecticides kill insects by acting detrimentally on the respiratory system. It will be sufficient for the purposes of this paper to indicate the position of spiracles of this insect, because they are the orifices through which the insecticides must act. There are two pairs of spiracles on the ventral side of the insect. In the larva the first pair is situated on the prothorax just behind and outward from the bases of the anterior legs, the second pair between the meso and metathorax behind and outward from the bases of the middle legs. The position of the spiracles of the adult female is shown in the accompanying drawing; in this stage the insect loses its antennae, legs, etc. The spiracles being on the ventral side they are more or less protected by the body of the insect, and this fact lessens the chances of the spraying fluid reaching them.

Treatment.

I am inclined to suggest the following method of dealing with this pest. The insect confines itself mainly to the trunk, though it may spread a little way up the larger branches. Taking advantage of this fact, scrubbing the trunk and the bases of the larger branches with a hard brush and hot water is an excellent remedy. This should be done in winter when the eggs are dormant. Too much emphasis cannot be laid on the necessity for thoroughness in this operation. In the following May and June a close watch ought to be kept to find out when the insects are hatching out, because, however thorough the scrubbing may be, some eggs are sure to be left untouched. In order to kill these a weak solution of paraffin emulsion is quite suitable. They ought to be killed before they settle down. As the insects keep hatching out for more than a couple of weeks, several spraying operations are necessary, only those trees being sprayed which have insects on them. This involves a certain amount of observation on the part of the person in charge of the orchard. I have not touched on the subject of checks by natural enemies in this paper, because, I understand, the question forms the subject of investigation by someone else.

Conclusions.

1. The scale is most probably not a wax.

2. The ingredients of the spraying fluids in use have no solvent action on the scale.

3. Any good result obtained with these fluids depends on the physical property of the paraffin oil contained in them.

4. Scrubbing the trunks with a hard brush and hot water in winter, and then spraying with weak kerosene emulsion in the following spring only those trees which show newly hatched insects on them, are better methods of checking the spread of the pest.

I take this opportunity of thanking Prof. H. M. Lefroy, of the Imperial College of Science, for suggesting to me this subject. My thanks are also due to Prof. Schryver for assistance in the Bio-Chemical Laboratory of the College.

NOTES ON A FROGHOPPER ATTACKING SUGAR-CANE AT MARIENBURG ESTATE, SURINAM.

By C. B. Williams, M.A., F.E.S.

On the 19th June 1916, I visited for a few hours Marienburg Estate, Surinam, as froghoppers had been previously reported as occurring in sufficient numbers to cause injury.

The wet season was just commencing, the first heavy rains of the season having fallen the previous day and it rained heavily during part of my visit.

The froghopper (*Tomaspis tristis*, F.) was found commonly on two parts of the Estate which Mr. Sheddon, the Manager, pointed out as being most heavily infested last year. It was not in sufficient numbers to be doing any damage at present, but as the wet season is only beginning it will probably increase rapidly during the next few months.

The adult is much larger than the Trinidad species (*Tomaspis saccharina*, Dist.): the female is very dark brown, with two transverse irregular rows of three small orange-yellow spots on each fore wing; the male is paler brown and has in addition to the spots an orange yellow mark at the base of the wings externally. The adults are found sitting in the characteristic position, head upwards, at the base of the leaves of the cane. At the time of collecting (mid-day) they were sluggish and easily captured with the fingers. Fifteen adults were caught, of which 11 were females and only 4 males.

Eggs were not found in the wild state, but some were obtained from females in captivity which were given the choice of green leaves and moist dead trash. They were without exception laid in the dead trash. As is usual, they were embedded in the material, but in many cases were inserted more deeply than is usual in *T. saccharina*. Several eggs that were laid in a dead rolled-up leaf were inserted into the second, third and even fourth layer from the exterior. Seven females (of which one was freshly emerged and probably did not lay) laid over sixty eggs in the course of twenty-four hours.

The eggs are 1·37 mm. long by 0·33 mm. broad. They are pale dull yellow in colour, spindle-shaped, slightly less pointed at the posterior than at the anterior end, which may be visible on the outer surface.

The young, or nymphs, were found surrounded by their froth, usually under the leaf-sheaths of the cane from near the ground to three or four feet up. One was found in the rolled-up leaves at the top of the cane nearly five feet from the ground. I did not have an opportunity of examining the roots below ground, but Mr. Sheddon assured me that he has never seen any nymphs on the roots. This is an important difference in habit from both the Trinidad froghopper (*T. saccharina*) and the Demerara species (*T. flavilatera*, Urich).

The froth made by the nymphs is of the loose soft type similar to that made by *T. saccharina*, and not like the close stiff froth made by *T. pubescens*, F., one specimen of which I obtained from grass alongside one of the cane-fields.

Seventy-one nymphs were collected, of which 2 were in the first stage, 8 in the second, 14 in the third, and 47 in the fourth. This difference in numbers is, I think, entirely due to the greater conspicuousness of the older nymphs.

The first stage is 2–3·5 mm. long, has the antennae 5-segmented and no trace of wing-rudiments. The second stage is about 5 mm. long, has 6-segmented antennae and very slight wing-rudiments. The third stage is about 7–8 mm., has 7-segmented antennae and distinct wing-rudiments. The fourth stage is 12–14 mm. long, has 8-segmented antennae and long wing-cases. They are all pale yellow in colour, with a faint reddish tinge on the sides of the abdomen and dark mesothorax, metathorax and wing-cases. In the last stage just before the adult emerges the dark coloration is partly developed.

In the short time that I had in the field no natural enemies were observed.

This froghopper appears to be a possible serious pest of sugar-cane, but owing to its habit of attacking the cane above ground, it will not, I think, ever be so serious as the Trinidad species, for the stout stem is more able to withstand loss of sap than the roots. On the other hand, flooding the fields, as is done in Demerara for *T. flavilatera*, will have little or no effect on this species.

Judging by the numbers we were able to pick in a very short time, I should think that organised hand-picking, particularly at the beginning of the wet season, would be worth while, if the pest recurs again this year as commonly as it is reported to have done last August. The position of the nymphs above ground lends itself to control by spraying, if such a thing were considered possible. Light traps might be tried on a small scale until the porportion of the two sexes caught by them has been determined.

No trace of green muscardine fungus was observed on any insects in the cane-field. If this could be introduced, it might be very successful in view of the short and comparatively moist dry seasons in this country.

I find that there are specimens of this species in the Museum at Georgetown, Demerara, taken "somewhere in British Guiana," but neither Mr. Bodkin nor Mr. Moore has ever taken it.

The nearest related species in Trinidad is *T. guppyi*, Urich, an apparently rare species of which the habits are unknown.

THE ANOPHELES OF MALAYA—III. A NEW VARIETY OF A. ALBOTAENIATUS, THEO.

By A. T. Stanton,

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and

H. P. Hacker,

International Health Commission, Malaya.

Anopheles albotaeniatus was described by Theobald from specimens taken in Perak, Federated Malay States (Mon. Cul. iii, p. 88, 1903). It has also been recorded from the Malay Peninsula by Leicester (Stud. Inst. Med. Res., iii, pt. 3, p. 34, 1908) and Strickland (Bull. Ent. Res. iv, p. 140, 1914), from British North Borneo by Roper (Bull. Ent. Res. v, p. 147, 1915) and from Sumatra by Schüffner and Swellengrebel (Geneesk. Tijd. Ned. Ind. liv, p. 160, 1914) and Stanton (Ind. Jour. Med. Res. iii, p. 252, 1915). It is an uncommon species in the Malayan region and has not so far been met with outside it.

A distinct variety of *albotaeniatus* is now recorded and to this variety we propose to assign the name *montanus*.

The larvae of this mosquito were found, along with the larvae of *leucosphyrus*, Dön., and *aitkeni*, Theo., and occasionally with those of *umbrosus*, Theo., in shaded pools in the course of a jungle stream at Ulu Gombak, Selangor, 600 feet above sea-level. The water of the pools was clear, with dead leaves and twigs at the bottom.

Larvae of the species *umbrosus* and *albotaeniatus* have hitherto been recorded chiefly from coastal areas. Referring to the latter species Leicester says (Stud. Inst. Med. Res. iii, pt. 3, p. 35) " the larva is evidently capable of living in water of a very high degree of salinity."

We are indebted to Mr. F. W. Edwards of the British Museum who has kindly examined our specimens and aided us in fixing the systematic position of this Anopheline.

Anopheles albotaeniatus var. **montanus,** nov.

A large dark-coloured mosquito. Palpi unbanded. Wing costa dark-scaled, with two yellow spots. Abdomen without scales. Hind legs with fifth tarsal segment yellow-scaled and narrow yellow bands at base and apex of tarsal segments 1, 2, 3 and 4.

♀. *Head.* The usual upright forked scales clothe the occiput. *Palpi* uniformly dark-scaled. *Proboscis* black-scaled, with brown tip. *Antennae*: segments 3 and 4 with a few long outstanding scales.

Thorax. The scutum is clothed with long hairs and below each antero-lateral margin there is a tuft of black scales. *Scutellum* with long bristles. *Prothoracic lobes* with tufts of long black scales projecting anteriorly.

Wings. The distribution of spotting on the wing field closely resembles that of *Anopheles albotaeniatus*, Theo. (Mon. Cul. iii, Plate 1). The wing costa is dark-scaled, with one white spot at the junction of the middle and outer thirds, and one at the apex involving the 1st and 2nd long veins and the wing fringe opposite the termination of the 3rd long vein.

Legs. Black-scaled, unspeckled, with lighter banding as follows: on the front and middle pair narrow yellow bands at the tarsal joints, segment 5 clad with a mixture of yellow-brown and black scales; on the hind legs narrow yellowish bands at base and apex of tibia and tarsal segments 1, 2, 3 and 4, segment 5 with yellowish scales (fig. 1).

Abdomen clad with long brown hairs only.

♂. The markings of the male are identical with those of the female, except the wing markings, which differ as in other species of this group. The genital lobes carry a few scales on their outer surface.

Genitalia: Claspette spines 2, arising from prominence; inner short, recurved; outer long, tapering; accessory hairs present. A well developed internal spine about half way down the clasper. Harpagones blended; each bilobed. Ventral lobe with spatula-like club; inner lobe with two long hairs, one about the same length as the club, the other about half this length. The whole lobe is densely chitinised, smooth and rounded. Theca long, cylindrical, tapering, the apex recurved ventrally; lip carrying four or five small leaflets. Ninth segment well developed. Ventral processes long, stout and clubbed; anal lobe extending about half-way down the clasper.

These characters resemble very closely those of *A. sinensis*, Wied. (Christophers, Ind. Jour. Med. Res. iii, p. 389, 1916). The form of the inner claspette spine is different.

Mature Larva.

Average length at maturity 5·25 mm. The general colour is dark, with a light yellowish band on abdominal segment 3.

Head. In form and relative position the clypeal hairs most nearly resemble those of *Anopheles umbrosus* (*vide* this Bulletin, vi, p. 171, 1915). The inner anterior clypeal hairs are placed close together and are long and simple. The outer anterior clypeal hairs are about half the length of the inner and are branched, six to eight divisions arising from a single stem. The posterior clypeal hairs are widely separated from each other, short, and branched near the base into three or four divisions. The occipital hairs are long and carry six to eight branches.

As in other species of this group the *antenna* carries a long branched hair on its inner surface.

Thorax. The sub-median anterior thoracic hairs resemble those of *sinensis* and *umbrosus* (*vide* this Bulletin, vi, p. 161, 1915); the innermost of the group is divided near the end into five or six short branches. There is a rudimentary stellate tuft on the thorax.

Abdomen. Fully developed stellate tufts are borne on the third to seventh segments. On the first and second segments there are rudimentary stellate tufts. The leaflets of the stellate tufts of the mid-abdominal segments are lanceolate in form with serrated edge; their average length is 0·064 mm.

The Anopheline here described is one of a group comprising in addition the species *sinensis*, Wied., *barbirostris*, Wulp, *umbrosus*, Theo., and *albotaeniatus*, Theo. It is nearly related in markings of the adult and in its larval characters to *umbrosus* and *albotaeniatus*. From *umbrosus* it differs in leg markings, in the characters of the male genitalia, and conspicuously in the characters of the larva. From *albotaeniatus* it differs in the leg markings; thus, while in typical *albotaeniatus* about one-quarter only of tarsal segments 3 and 4 of the hind legs are dark-scaled (fig. 1), in the new variety about four-fifths of these segments are dark-scaled. The characters of the male genitalia and of the larva of *albotaeniatus* have not yet been described.

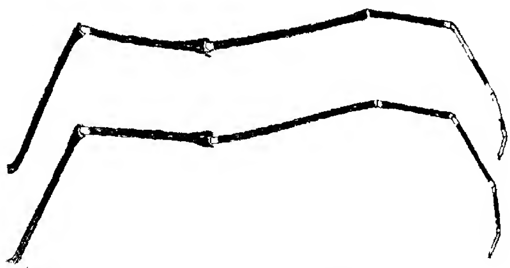

Fig. 1. Hind legs of *Anopheles albotaeniatus*, Theo. (above), and *A. albotaeniatus* var. *montanus*, nov. (below).

We have recently identified the mature larva of *Anopheles brevipalpis*, Roper, an unspotted-winged Anopheline, and find that, though the adult of this species bears no resemblance to those of the group under consideration, the larva differs very little from that of *umbrosus*, Theo. The egg and early stages of the larva of *brevipalpis* have been described by Strickland (Ind. Jour. Med. Res. iii, p. 201, 1915). We find that in the mature form the inner anterior clypeal hairs are placed close together and are forked, that the outer anterior clypeal hairs have short stems, otherwise resembling those of *umbrosus*, and that there is no stellate tuft on any segment of the abdomen.

The following table shows how the mature larvae of these species may be recognised.

1. Shaft of antenna with a branched hair 2
2. Outer anterior clypeal hair thickly branched 3
   Outer anterior clypeal hair with few branches 4
3. Innermost sub-median anterior thoracic hair branched from base *barbirostris*.
   Innermost sub-median anterior thoracic hair with simple stem and short terminal branches .. .. *sinensis*.
4. Abdominal segments without stellate tufts 5
   Abdominal segments 3 to 7 with stellate tufts .. *albotaeniatus* var. *montanus*.
5. Inner anterior clypeal hair simple or with minute lateral branches *umbrosus*.
   Inner anterior clypeal hair forked .. .. *brevipalpis*.

We are indebted to Miss R. Ford for the drawings which accompany this paper.

THE LIMITATIONS OF KEROSENE AS A LARVICIDE, WITH SOME OBSERVATIONS ON THE CUTANEOUS RESPIRATION OF MOSQUITO LARVAE.

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Of all the measures designed to effect a reduction in the number of mosquitos "oiling," or the application of kerosene in one form or another to collections of water in the neighbourhood, is I suppose the favourite. The popularity of this measure is no doubt an indication of its general efficiency, and as it is a remedy that can and should be employed by the individual as well as by the Sanitary Authorities, it has become familiar to every dweller in the tropics. This familiarity has, I believe, led to an exaggerated confidence in its efficacy.

When Ross (1899) in Sierra Leone first elaborated the method as a public health measure, it was with a view to the destruction of malaria-carrying mosquitos and those Culicines that breed in and near human habitations. So great has been the success following its adoption in certain conspicuous undertakings, that the general public has come almost to believe that by "oiling" it should be possible to banish mosquitos entirely from towns and stations, and surprise is expressed if the Sanitary Authorities fail to effect this reduction. It is too often forgotten that many localities are ill-suited for the application of this method, that many surfaces of water cannot be efficiently oiled, and that by no means all the species of mosquitos that bite man breed close to houses.

At Accra, the capital of the Gold Coast Colony, "oiling" with crude kerosene is carried out by the Sanitary Authorities in a most thorough manner, and a great reduction in the number of mosquitos in the houses is said to have resulted. Nevertheless mosquitos are still very far from rare, and the reasons for this are not difficult to trace. Accra is a wind-swept town, and oil applied to a surface of water, no matter how carefully, is soon driven to one side, leaving the more exposed parts with only a broken film, through which the larvae may safely come to the surface. Even a very large quantity of oil in proportion to the area fails to maintain an unbroken film for the long period that, as will be shown later, many larvae can survive without rising to the surface. Accra is also a sunny and relatively dry town, and evaporation is rapid and prejudicial to the success of oiling.

More important than these reasons, however, is the fact that the majority of the mosquitos found in the houses, and which therefore especially concern man, are of species that do not breed in the immediate vicinity of dwellings. As has been shown elsewhere, the larvae most frequently found in the compounds are those of *Stegomyia*

fasciata and *Culex fatigans*, but the commonest mosquitos in the houses are *Mansonioides africanus* and *M. uniformis*. The peculiar habits of the larvae of *Mansonioides* and their association with the water-weed, *Pistia stratiotes*, make it possible to locate their breeding places fairly accurately, and it can confidently be affirmed that at Accra these mosquitos must often fly more than a mile. It is useless to expect, or even to hope, for a total abolition of mosquitos by oiling in these circumstances.

Another feature at Accra that militates against the success of "oiling" is the presence of lagoons of such a size and in such situations that it is impracticable to deal with them by this method. In the brackish water of these lagoons *C. thalassius*, a species often found in the houses in Accra, breeds freely. The larvae, it is true, seem to be limited to the shallow margins of the lagoons, but this does not render them vulnerable to "oiling," and as will be mentioned later, this species is able to live submerged for a very long time without having direct access to the air.

The Mode of Action of Kerosene as a Larvicide.

Many methods of applying the oil have been recommended, and the amount necessary per square metre of surface has been estimated at widely differing figures. For small pools Ross (1911) advocates "painting" the oil over the surface with a bunch of rag tied to the end of a stick; but such details, he says, are unimportant, the essential point being, as he has stated elsewhere (1900), that "the film must spread all over the surface of the water, and must last for at least half an hour." In each locality the best method of application and the amount of oil required per square metre must be determined by experiment. The presence of weeds must also be considered, as they interfere with the action of the oil, probably by breaking the film. In laboratory experiments, however, the mere presence of organic matter in the water is found to diminish the action of crude kerosene. This is illustrated by the experiment summarised in Table 1, in which young larvae of *Stegomyia fasciata* were used, namely larvae less than 24 hours old and still in the first phase of their development. The larvae were kept in identical vessels in (1) distilled water, (2) tap water, and (3) a natural *S. fasciata* medium, all being fluids in which control larvae lived for days. The kerosene was applied to the surface in a proportion equal to 110 cc. per square metre, and as will be seen from the table, its action was much more pronounced in the pure medium. In the media containing much organic matter, indeed, some of the larvae escaped its action and were still alive after 57 hours, when the experiment was ended as it was thought that lack of food might be becoming an appreciable factor. There was still a continuous film of oil over the surfaces of the media when the experiment was discontinued. Why this should be so I am unable to explain, for, as will be shown later, solution of the oil does not appear to play any part in its larvicidal action, and the fact is all the more remarkable because in other circumstances the presence of organic matter tends to diminish the period during which submerged larvae can survive. But perhaps it may have been due to the tendency shown by the larvae of *S. fasciata*, and indeed of most if not all mosquito larvae, to lie at times in an apparently inert condition on the mud or debris at the bottom. In this "resting" state their oxygen absorption may be but slight, and if they remain below long enough, they may escape the more pronounced action of kerosene and on eventually coming to the surface may have to encounter only a thin film of the oil.

TABLE I.

Experiment showing the action of crude kerosene on the larvae of *Stegomyia fasciata*. Five larvae in the first phase were used in each experiment.

Time after the beginning of the experiment.	Crude kerosene (about 100 cc. per sq. metre) applied to		
	A natural *S. fasciata* medium.	Tap-water containing a fair amount of organic matter.	Distilled water.
3 hours ..	1 dead, 4 alive	2 dead, 3 alive	2 dead, 3 alive.
4 " ..	4 alive	3 alive	1 dead, 2 alive.
5 " ..	"	"	1 dead, 1 alive.
7 " ..	"	2 dead, 1 alive	1 alive.
8 " ..	1 dead, 3 alive	1 alive	"
12 " ..	3 alive	"	1 dead.
36 " ..	"	"	
57 " ..	"	"	
	Experiment discontinued..		

The oil may be supposed to act in one of several ways; as for example "by annulling the surface-tension of the water," by depriving the larvae of access to the air and so drowning them, or by some poisonous effect on the larvae themselves.

By annulling the surface-tension. Ross (1911) has suggested that as the result of "oiling" the "larvae and pupae are no longer able to keep the surface by surface tension and quickly drown." In the course of a long series of experiments with many different species of larvae I have never observed this effect; on the contrary, indeed, Anopheline larvae (*A. costalis*) and larvae with long siphons (*Culex invidiosus*) were apt to be caught and carried to the surface if the layer of oil were thick. When the oil film was thin, larvae such as those of *Stegomyia fasciata* and *Culex fatigans* appeared to have no difficulty in adhering to the surface, and the former were repeatedly observed in what looked like a vigorous attempt to drive their siphons through the film.

By depriving the larvae of access to the air. This is perhaps the most common view of the action of "oiling." Celli (1904), for example, states that both oil and petroleum "have a mechanical action only, that is, by intercepting the air from the larvae, which require much oxygen," and emphasises the fact that if the whole surface of the water is not covered by the film of oil the larvae do not die. Others have supposed that the oil enters the siphon tubes and blocks them, thus preventing the larvae from breathing air freely. As this theory is necessarily involved in considering the action of kerosene as a poison, and as it is intimately connected with the question of cutaneous respiration that will be dealt with later, it will not be discussed here.

By a poisonous action. The oil might exercise a poisonous action on the larvae either by being dissolved in the water and acting on them in solution, or by entering the tracheal tubes in the siphons when the larvae came to the surface to breathe.

Kerosene in its various forms is only very slightly soluble in water, and as the total amount used in " oiling " is always extremely small as compared with the total bulk of the water over which it is applied, the quantity dissolved might be supposed to be negligible. Moreover, as the oil remains at the surface, the solution would be strongest at the surface and one might expect that the larvae rising to breathe would become aware of the poison in time to recede from it before it became powerful enough to injure them.

In the course of my experiments it sometimes happened that bubbles of air separated on the sides of the vessel in which the larvae were confined. In this case it was found that larvae of *Stegomyia fasciata* might live for certainly several days under a film of kerosene presumably obtaining the necessary oxygen from the air bubbles. As in these experiments the volume of water was relatively small the larvae would almost certainly have been affected had kerosene acted appreciably in solution. The larva of *Mansonioides africanus* is particularly suitable for experiments of this nature, as it does not require to come to the surface at all to breathe and can therefore be kept under a deep layer of kerosene for a long time, during which it would, however, be exposed to the action of any part of the oil which might be dissolved. In one such experiment a larva was kept in a jar of water to the surface of which crude kerosene had been added in an amount corresponding to 100 cc. per square metre. For three days it appeared to be unaffected, and on the fourth day it pupated.

From these observations it may be concluded that in " oiling " the action of kerosene is independent of its solubility in the water to which it is applied.

The vapour given off by the oil might be expected to act on the larvae when inhaled into the tracheae during respiration. Sen (1914) has recorded a single experiment in which a few drops of kerosene placed on a cotton plug in the stopper of a jar half-filled with water in which mosquito larvae (*C. microannulatus* ?) were living appeared to have a fatal effect. " Apart from the presence of vapour," he says, " there was no apparent reason why the larvae . . . should not have lived as long as those in the control, as no definite surface-film was formed under the conditions of the experiment."

I have not been able to repeat Sen's experiment with the species of larvae he employed, but I have satisfied myself that in the case of *Stegomyia fasciata* and *Culex fatigans* kerosene applied in this manner has an effect. Its action was most marked on the species with the longer siphon, but was less constant and much slower than that produced by a film of oil. Sen speaks of the vapour as having an " anaesthetic " effect. In my experiments the larvae undoubtedly often became sluggish when they were not actually killed, and tended to remain adhering to the surface of the water, being abnormally difficult to disturb; while some which appeared to have been killed recovered when transferred to shallow vessels away from the kerosene. In actual practice the vapour must be very rapidly distributed by currents of air, and it may be doubted if it is ever sufficiently concentrated long enough for its action to have any importance.

A third manner in which kerosene oil may act as a poison is by entering the tracheal tubes through the siphon and either blocking them or spreading into the finer branches and acting directly on the tissues of the larvae.

The larvae of *Culex fatigans*, which have long siphons (about four times as long as the diameter of the base), succumb rapidly to the action of oil. Larvae in the fourth phase, the last stage of their development, are almost invariably killed within half an hour by "oiling," but if they are prevented from coming into actual contact with the film of oil they survive longer. In one experiment six *C. fatigans* larvae in the fourth phase were isolated singly in six identical glass tubes each containing 8 cc. of distilled water. A small plug of wool was placed in each tube just below the surface of the water, and then to three of the tubes a layer (one cm. deep) of melted paraffin was applied, and to three a similar layer of crude kerosene. The larvae confined under the layer of paraffin were found to be dead after 3, 3½, and 6 hours respectively, and those under the kerosene after 3½, 6½, and 7½ hours. Allowing for individual variations in the power of resistance, it appeared that the larvae, prevented as they were from reaching the surface by the plug of wool, lived about equally long whether they were under a seal of paraffin or kerosene—that is, the kerosene in this case had no specific action, but, likethe paraffin, deprived the larvae of access to air and so drowned them. Anything therefore, such as the presence of organic matter, which tends to use up the available oxygen in the tubes should accelerate the death of the larvae under such conditions. This was found to be the case; for when a natural *C. fatigans* medium was used instead of distilled water, the larvae survived under paraffin only 65, 70, and 80 minutes; and under kerosene 65 and 70 minutes. The third larva confined under a layer of kerosene in this experiment succeeded in wriggling through the wool plug and reached the surface for a moment. It at once returned below the wool and did not again get above it, but this larva died after 35 minutes.

These experiments prove that the action of kerosene on the larvae of *Culex fatigans* is not dependent on the solution of any part of the oil in the water, and is not entirely due to deprivation of oxygen, but is the result of some direct action of the oil on the larvae. Were it merely a blocking of the tracheae in the siphon, the larvae should be able to live as long as they do under a layer of kerosene from which they are separated by a light plug of wool. It is probable therefore that some of the oil enters the siphon tracheae and is drawn into the body of the larvae, where it exerts a poisonous action.

In the case of *Stegomyia fasciata*, however, the action seemed sometimes to be different. In a mass experiment a sample of these larvae in the fluid in which they had been found was divided into two equal parts and poured into two similar bottles so that the fluids reached just into the narrow necks. The one bottle was then sealed with a layer of paraffin one cm. deep, and the other with a similar layer of crude kerosene. The larvae survived about the same length of time in each, all being dead after 6 hours. The pupae in both were all dead after 1½ hours. Similarly, in more detailed experiments the larvae of *S. fasciata* appeared to be able to resist the action of kerosene; and one experiment (see Table I) has already been mentioned in which these larvae lived for over two days under an unbroken film of oil. The oil did not appear to have any direct action on them.

The larvae of *Stegomyia fasciata* differ from those of *Culex fatigans* in having short stout siphons, which they may often be seen to thrust against the film of oil, as if

endeavouring to pierce it. In doing this they keep the valves tightly closed, and failing in their attempts, they wriggle down into the water again. In this way I believe they may sometimes avoid drawing oil into their tracheae, and so escape the direct action of the kerosene. If, however, oil does enter the siphon, as probably happens eventually in the case of fully developed larvae confined under a deep layer of kerosene, it acts in a manner similar to that described in the case of *C. fatigans*, namely, as a direct poison. In one experiment six fully developed larvae (fourth phase) from the same sample were placed in couples in three tubes each containing 8 cc. of the fluid in which they had been living. One tube was then closed with a layer of crude kerosene one cm. deep, one with a similar layer of olive oil, and the third with paraffin. The larvae were found dead after $1\frac{1}{2}$ and $1\frac{1}{2}$ hours in the first tube, after 2 and $2\frac{1}{2}$ hours in the second, and after 2 and $2\frac{1}{2}$ hours in the third. The kerosene, then, seemed to cause death more quickly than did the paraffin or the olive oil, which merely deprived the larvae of access to air. It is interesting that the olive oil seemed to have the same action as the paraffin, for it was of course fluid and just as likely as kerosene to enter the tracheae of the siphon and block them. The fact that olive oil acted differently from kerosene is additional proof that the action of the latter is not due to a mechanical blocking of the siphon tracheae.

The difference between the survival time under kerosene and paraffin was, however, sometimes so inconsiderable as to suggest that the larvae had escaped the poisonous action and had succumbed mainly as the result of being prevented from breathing the external air, and it was found that the larvae in different experiments survived very different lengths of time, and this led to a series of observations being made on the oxygen requirements of submerged mosquito larvae, a short account of which is given in the following pages.

The Survival of Submerged Mosquito Larvae.

In order to determine the length of time mosquito larvae can survive when submerged, and the factors influencing this survival, it was necessary to decide on one standard method of carrying out the experiments. Da Costa Lima (1914) and Sen (1914) have recorded the results of experiments on "drowning" mosquito larvae. The former confined the larvae in glass flasks filled with well-aerated water and covered or stoppered, submerged in larger vessels of water, and the latter used test-tubes capped with gauze and immersed in basins of water. Both these methods in my hands proved to be unsatisfactory, because now and then, especially when tap-water was being used, minute bubbles of air separated on the sides of the submerged vessels. These bubbles were sometimes so small as only to be clearly visible with the aid of a lens, but as they appeared to influence the course of the experiments, all confidence was lost in the technique. There was an additional disadvantage in the case of Sen's method, for not only were air bubbles apt to form on the glass tubes and the gauze covers, but also it was practically impossible to be sure that a film of air, or a small bubble, did not adhere to the mesh of the gauze.

After trying a great many different methods—such as the use of specific-gravity bottles, test-tubes simply inverted in a basin of water, etc.—it was decided that for the present purpose it was most satisfactory to confine the larvae singly in small tubes holding about 8 cc. of fluid, and to effect their submergence by covering the surface

of the fluid with a layer of soft paraffin one cm. deep. The paraffin was melted before being poured into the tubes and thus spread evenly over the surface of the water leaving neither air film nor bubbles, and formed a smooth covering effectually cutting off the larva from all contact with the air. Some difficulty was experienced in determining the most suitable hardness for the paraffin, for if it were too soft it did not solidify sufficiently on coming into contact with the fluid, and larvae rising to the surface might get caught by it, and if it were too hard it was apt to shrink away from the sides of the tubes. When once the right consistency had been ascertained, however, the method worked well.

The larvae were of course confined in a very small quantity of fluid (8 cc.) and in a restricted space; but a large number of control experiments proved that the species used in my experiments, namely *Stegomyia fasciata* and *Culex fatigans*, were not in any way incommoded by these conditions and completed their life-cycles in such tubes in a normal manner. I do not think therefore that pollution of the fluid need be considered as a factor in these experiments, especially as they were seldom continued for longer than a day, but as the amount of fluid was so small it could only hold in solution a minute quantity of oxygen that might be available for the larvae when access to the external air was cut off by the layer of paraffin. Other experiments by other methods were therefore necessary to ascertain the value in respiration of the dissolved oxygen, but in determining the factors influencing the survival of submerged larvae the standard method described above was employed.

Another factor that had to be considered was starvation, or the lack of suitable food in the fluids used. This factor may also be neglected, I believe, because larvae of the species employed were found to live perfectly well in tubes of distilled water and eventually completed their development in them, if they were left with free surfaces exposed to the air. The period of the cycle was of course prolonged, as at first the medium was devoid of all food materials, but the fact that the larvae did not die shows I think that starvation would not affect the larvae appreciably in the relatively short times occupied by the experiments.

Factors Determining the Survival of Submerged Larvae.

The Species of Mosquito. As might be expected, mosquito larvae of different species showed very great differences in their ability to survive when cut off from access to the air.

In one experiment carried out in the standard method described above, five larvae of *Stegomyia fasciata* and three of *Culex fatigans* were used. The fluid in this case was a natural medium full of vegetable debris, etc. The tubes were examined every hour. One of the *S. fasciata* larvae was found to be dead after 6 hours, three after 7 hours, and the fifth after 8 hours; that is, the average length of time the larvae survived was about 7 hours. All the three *C. fatigans* larvae were found dead after 2 hours.

In another experiment carried out by Sen's method with five larvae each of *S. fasciata*, *C. fatigans* and *C. invidiosus*, it was found that all the *C. invidiosus* larvae and three of *C. fatigans* were dead after 30 minutes, that one *C. fatigans* larva was dead after 45 minutes, and the last after one hour, but that all the *S. fasciata* larvae were still alive after two hours. It is perhaps of some significance that the proportion

of the basal diameter to the length of the siphon is in the case of *C. invidiosus* 1 : 8, in *C. fatigans* 1 : 4, and in *Stegomyia fasciata* 1 : 2 ; for Sen has expressed the opinion that "*Stegomyia* can withstand want of oxygen better than *Culex*," an observation which he says "appears to have a natural connection with the respective lengths of their respiratory siphons."

The Age of the Larvae. The age of the larvae is also an important factor, young larvae being able to survive longer than fully developed ones. For example, in an experiment carried out in a fluid rich in organic matter five fully grown and five very young larvae of *S. fasciata* were used. The fully grown larvae were found dead after 3, 4, 5, 5, and 6 hours respectively, the average being 4·6 hours, and the young larvae after 6, 6, 7, 7, and 7 hours, the average being 6·6 hours.

It was necessary therefore to use larvae of known ages in subsequent experiments; that is, larvae in a known phase of their development, for of course a knowledge of the number of days that have elapsed since the larvae emerged from the eggs is no sure guide as to the stage of development to which they have advanced. As it is not always easy to determine rapidly larvae in the second and third phases it was decided to use only larvae in the first and last phases, that is, larvae that had not yet cast their first pelts, and larvae that had already cast their third pelts.

Individual variations are of course very considerable, but by employing only larvae at known stages of development it was found that much more constant and uniform results were recorded.

The Temperature. Many of the experiments on the survival of submerged larvae lasted a long time, so that although started early in the morning they were not finished by nightfall. In some of them it seemed as if the larvae still alive at sunset survived an abnormally long time, and it was suspected that this might be due to the coolness of the evening and the night. Some experiments were therefore carried out to determine what effect different temperatures might have. All the experiments were conducted by the standard method in distilled water which had been kept at the desired temperature for some hours before the larvae were introduced into it. The larvae employed were those of *S. fasciata* in the fourth phase.

In order to test the action of a lowering of the temperature, five larvae were placed in an incubator at 22° C., and five in one at 37° C., one evening at 6 p.m. Next morning at 8 a.m., that is after 14 hours, all the larvae exposed to the higher temperature were dead, but all those at 22° C. were alive. The experiment was therefore continued. At 6 p.m., all the larvae in the cold incubator were still alive, but at 8 a.m., on the third morning, that is after 38 hours, three were found dead. Of the two remaining larvae one was found dead after 39 hours, and the other after 40 hours.

As all the larvae in the incubator at 37° C. had been found dead at the first examination in this experiment, five more larvae were exposed to this temperature during the day-time when they could be watched carefully. Two were found dead after 4 hours, and the remaining three after 5 hours.

The usual temperature of the laboratory at Accra where these experiments were carried out was about 30° C. during the day-time. At the natural laboratory temperatures *S. fasciata* larvae in their fourth phase lived about 12 hours in distilled water under the standard conditions, but there was of course a considerable lowering

of the temperature towards evening which must be remembered. Five larvae that were observed continuously were found dead after 10, 10½, 12, 12, and 12¼ hours respectively. Three larvae kept simultaneously in the incubator at 37° C. were all alive after 6, but all dead after 7 hours.

There can therefore be no doubt that a lowering of the temperature prolongs and a raising of it shortens the period of survival of submerged *S. fasciata* larvae; and this one may suppose is due to a variation in the activity of metabolism, that is in the rate of absorption of oxygen.

The Presence of Organic Matter in the Medium. The presence of organic matter in a medium profoundly modifies the power of survival of larvae submerged in it.

In one experiment conducted on the usual lines, fifteen very young *S. fasciata* larvae (first phase) were used, five each in (A) a natural *S. fasciata* medium containing vegetable debris, (B) tap-water containing a little organic matter, and (C) distilled water. In (A), the natural medium, the larvae were found dead after 6, 7, 7, 7, and 8 hours respectively; and in (B), the tap-water, after 10, 12, 13, 14, and 16 hours. In (C), the distilled water, all the larvae were still alive after 16 hours, but after 24 hours, when the tubes were next examined, three were found dead; the fourth cast its first pelt and died between the 31st and 32nd hours, and the last larva was found dead after 33 hours.

In a similar experiment with *Culex fatigans* larvae in the fourth phase the results were similar, but the periods of survival were, of course, shorter. In the natural medium the three larvae used were all dead after 2 hours; in the tap water one larva was dead after 3 hours, and two after 4 hours; and in the distilled water the larvae were found dead after 4, 4, and 5 hours respectively.

The presence of organic matter undoubtedly materially shortens the period during which mosquito larvae can survive when submerged in a fluid. As the larvae were prevented from obtaining direct access to air by the conditions of the experiments, it seems natural to suppose that the action of the organic matter is associated with its effect in absorbing and using up the oxygen dissolved in the fluids. If then the dissolved oxygen were to be expelled from the fluid by some other means, as for example by boiling, we ought to produce a similar effect on the larvae.

A number of experiments were therefore carried out with boiled water, both *S. fasciata* and *C. fatigans* larvae being employed. In these experiments the water was thoroughly boiled in the tubes, the paraffin added, and the tubes allowed to cool. The medium was thus cooled out of contact with air and therefore could not have reabsorbed oxygen. When the experiment was to be started the paraffin was quickly pushed to one side with a glass rod, the larva introduced with a pipette, and the paraffin melted just sufficiently to reseal the tube. As the larvae always sank to the bottom of the tubes when they were first introduced, there was no danger of their being injured in the last operation.

The results of these experiments were somewhat confusing owing to individual larvae surviving unexpectedly long, but for some of these variations the fall of the temperature at night may have been responsible. There could, however, be no doubt but that the larvae in tap or tank water that had been thoroughly boiled survived a much shorter time than did those in the control tubes of unboiled water, and this applied equally to *S. fasciata* and *C. fatigans*, and to both young and fully developed larvae of both species.

It is probable therefore that the shorter period of survival of larvae submerged in fluids containing organic matter is in fact due to the smaller quantity of dissolved oxygen present in them.

The Presence of Water-weeds. As might have been expected, water-weeds that float on the surface and have only their roots submerged appeared in my experiments to have the same effect as dead organic matter. There are, however, other weeds which float more or less submerged or grow partly in and partly out of the water, and as these are green plants they presumably give off oxygen during the day-time, and the minute chlorophyll-containing organisms so common in pond water presumably do the same. The question then arises whether this oxygen given off by green water-weeds, etc., can prolong the life of mosquito larvae that are prevented from reaching the air at the surface.

In a single experiment with *S. fasciata* larvae in their fourth phase there did appear to be some prolongation of life. The experiment was carried out in the usual manner, six larvae being confined in six tubes of distilled water. To three of the tubes a small piece of a green water-weed was added, the other three being used as controls. In the tubes containing weed the larvae were found dead after 11, 12, and 13½ hours respectively, and in the controls after 10, 12, and 12½ hours. Now if the weed did not give off oxygen that was available for the use of the larvae it should have acted merely as organic matter, which has already been shown to accelerate the death of submerged larvae. Since however the larvae lived a trifle longer in the tubes containing the weed, it seems probable that the oxygen evolved by green plants, etc., can be of service to the larvae.

The leaves of some water-weeds are often found partly submerged, either as the result of growth or of some accidental circumstance. The outer leaves of *Pistia stratiotes*, for example, droop on to the water as the centre of the plant unfolds and eventually come to lie parallel with the surface of the pool. For some time, however, they are in contact with the water only at their edges, and under them there is an air space to which oil applied to the surface of the pool would not have access. The surfaces of the leaves of *Pistia stratiotes* are also unwetable and carry down with them into the water a film of air which appears to be of service to some species of mosquito larvae at any rate. The larvae of *Mimomyia splendens*, for instance, seem to make use of this film of air for respiration by preference.

From what has already been said it is clear that the survival of submerged mosquito larvae is influenced by a great many different factors, and any attempt to estimate the length of time larvae can live without access to the external air must take into consideration not only the species and the age of the larvae, but also the temperature, the degree of oxygenation of the medium, the amount of organic matter present, and probably other conditions. So complex is the question that it is practically impossible to arrange any series of experiments the results of which will be comparable in detail. By carrying out a large number of experiments on similar lines it is possible to arrive at certain general conclusions, and for the present purpose—namely, as bearing on the efficiency of "oiling" in anti-mosquito measures—these are probably sufficient. In small tubes of about 8 cc. capacity the mature larvae of *Stegomyia fasciata* at laboratory temperatures seldom survived over 6 hours, and

generally only 2 to 4 hours, when submerged in their natural medium; but in tap-water or distilled water they survived twice as long or even longer. Young larvae, that is larvae in the first phase of their development, lived about the same length of time or a little longer (6 to 7 hours) in a natural medium; but survived much longer (about 30 hours) in fluids containing little or no organic matter. Similarly mature larvae of *Culex fatigans* did not survive so long as young larvae, but in the case of this species the period of survival was shorter under all circumstances, the mature individuals dying in less than 2 hours in a natural medium, and seldom surviving as long as 6 hours even in distilled water.

The Part Played by Cutaneous Respiration during Submergence.

As has already been explained, these experiments were carried out in very small volumes of fluids, as they were designed to determine the factors influencing the survival and did not aim at estimating the part played by cutaneous respiration. The results, however, clearly suggested that the larvae died in consequence of the reduction, by various conditions, of the dissolved oxygen to an amount that ceased to be of use for cutaneous respiration. In actual practice the larvae that it is sought to destroy by "oiling" are not confined in small vessels, and although the medium in which they are found is generally rich in organic matter, it is reasonable to suppose that it must often be a very long time before the dissolved oxygen is exhausted or reduced to a point at which it is no longer serviceable to them.

The question of the cutaneous respiration of mosquito larvae has been studied by Lima and Sen, and their observations will be discussed presently; but as they recorded dissimilar results, and as I believe their methods were in some respects unreliable, it seemed advisable to reinvestigate the matter. Some preliminary experiments were therefore carried out, using (A) small tubes, and (B) large bottles of a capacity of 1800 cc. In each experiment a small tube and a large bottle were placed side by side in the laboratory under the same conditions, were filled from the same jug of water, and were sealed with paraffin from the same sample. Two *S. fasciata* larvae from the same batch and in the same phase of development were used in each experiment, the one being placed in the small tube and the other in the large bottle. In one experiment of this sort *S. fasciata* larvae in the fourth phase were used and tap-water that had previously been thoroughly shaken up with air. The experiment was started one afternoon at 2.15 p.m. The larva in the small tube was still alive at 5 p.m., but was dead before 8.15 a.m. the next morning (18 hours). The larva in the large bottle was still alive after 50 hours, but was dead after 51 hours. A slightly younger larva, third phase, unintentionally introduced into the large bottle survived until the twentieth day, by which time a little green growth had appeared at the bottom of the bottle which may have helped to prolong its existence.

When tap-water is being used for such experiments, it must be remembered that its degree of aeration is liable to great variation, and it is better therefore to use only water that has previously been thoroughly oxygenated by shaking up with air. In one of my experiments the small tube and the large bottle were filled from the tap in the laboratory in the early morning, a *S. fasciata* larva (fourth phase) added to each, and the vessels sealed with paraffin in the usual way. An hour later I was surprised to find that both larvae were moribund, and within two hours both had died.

In the light of later observations it must I think be concluded that the tension of the dissolved oxygen in the water drawn from the tap was already at the beginning of the experiment so low as to be valueless to the larvae for cutaneous respiration. In this case the tap-water used had been lying stagnant in the pipe for at least twelve hours and much of the oxygen originally dissolved in it must have been absorbed.

It is possible that some similar reason may account for the relatively short period (6 or 7 hours) Sen found that submerged larvae might survive; for although he immersed his tubes in "large basins," he did not change the water, and if the amount of dissolved oxygen were very small, it would be useless to the larvae no matter how great the volume of the water. Indeed, in some circumstances the water may be able actually to withdraw some of the oxygen from the bodies of the larvae and so shorten the time of their survival, and in this case the larger the volume of water the more rapid would be the death of the larvae.

Probably *Stegomyia fasciata* larvae require much less oxygen than larvae of species of *Culex*. In some experiments with fully developed *Culiciomyia nebulosa* larvae I could detect no marked difference in the length of time they survived when submerged in large and small volumes of thoroughly aerated tap-water. Indeed, they sometimes survived longer in the smaller volume, as for example in one experiment in which a fully developed larva in 7·5 cc. survived between 2 and $2\frac{1}{2}$ hours, while one in 750 cc. of the same sample of water survived only between 1 and $1\frac{1}{2}$ hours. From this it must be concluded that this species when fully developed is incapable of accommodating itself to living without access to the external air even in thoroughly aerated water.

The Proportion of the Dissolved Oxygen available for Cutaneous Respiration.

Theoretically at 30° C., which was about the laboratory temperature in the day time, water should dissolve 5·8 cc. of atmospheric oxygen per litre. The tap-water used in my experiments was probably not fully saturated on the one hand, and on the other the temperature was sometimes below 30° C., when more oxygen should be dissolved, so that very roughly we may suppose that the water used contained about 5 cc. dissolved oxygen per litre. In the 8 cc. in the small tube there should therefore have been 40 c.mm., and in the 1800 cc. in the large bottle 9,000 c.mm. of oxygen in solution.

It has been calculated by Sen that a fully developed larva of *C. microannulatus* consumes oxygen at the rate of 1·1 c.mm. per hour. Assuming that this figure is approximately correct, and that the larva of *S. fasciata* consumes oxygen at about the same rate, there was enough dissolved in the water in the tube to keep one larva alive for 36 hours if it had all been respirable. As a matter of experience, as has already been shown, a fully developed larva of *S. fasciata* when kept submerged in tap-water survived only about 12 hours, and as in boiled water, which presumably contained no dissolved oxygen, it survived say 4 hours, the oxygen in solution in 8 cc. of water served only to keep it alive for about 8 hours. Adopting Sen's figure, this means that only 8·8 c.mm. of the 40 c.mm. in solution was available for respiration, or in other words only about one-fifth of the oxygen dissolved in water that has been thoroughly aerated is available for the larva for cutaneous respiration. If therefore the water is less than four-fifths saturated with atmospheric oxygen, it will not be respirable at all.

Theoretically, then, the thoroughly aerated water in the large bottle should contain enough oxygen in solution to supply the requirements of one fully developed larva for 68 days. There are, however, many reasons why the period of survival should be shorter than that theoretically possible. For example, it is not natural for the larva to respire in this manner, and the fully developed individuals are not able to adapt themselves to the unnatural conditions so well as are younger larvae. Also the water, although cut off from the air, is not sterile and organisms grow in it, and must absorb some of the oxygen. It is on these organisms that the larvae feed.

When young larvae are used, they are found to adapt themselves much more easily, and if they do not actually survive the length of time they theoretically might, they nevertheless live for many days, grow in size, moult and develop fully.

In order to have studied this question adequately it would have been necessary to determine the respiratory exchange of each species of larva dealt with, as well as the variations occurring under different conditions of temperature, etc. As it was not possible to do this with the apparatus available, the subject was not pursued further, but even these incomplete observations support Lima's conclusion that larvae when denied access to the air can live only in well-aerated water.

The Survival of Mosquito Larvae Submerged in Slowly-running Water.

Having ascertained in these preliminary experiments that *S. fasciata* larvae are able to live a long time respiring only dissolved oxygen, an attempt was made to reproduce more nearly the conditions present in a pool or stream in which the water is not held fast until its oxygen is exhausted, but is able to circulate more or less freely. The apparatus used is shown in figure 1. It was composed of a cylindrical glass tube (AB) of 700 cc. capacity, firmly corked at both ends, and provided with an inlet at C and an outlet at D. A large glass funnel was attached to the inlet by a rubber tube, and into this funnel water from a tap was allowed to drip. To the outlet a short rubber tube fitted with a screw clamp (E) was attached, by means of which the flow of water could be regulated. The actual vessel used by me was the water-jacket tube of a Liebig condenser. In order to ensure the oxygenation of the water, it was delivered as a spray from a finely pointed glass tube (G) fixed about two feet above the funnel.* When an experiment was to be started, the end A of the vessel was lowered and water allowed to run in, the clamp E was tightened and the vessel filled up, the larva or larvae introduced at B, the end A lowered until the water overflowed at B, and the cork at this end was then thrust home. In this way air bubbles were completely avoided. The inlet and outlet had of course to be blocked by loose pads of wool, cylinders of gauze, or some such contrivance, so as to prevent the escape of the larvae.

Under these conditions, so far as could be observed, the larvae of *Stegomyia fasciata* lived in comfort. Young larvae grew and moulted in a normal manner, and both young and fully developed larvae moved freely about the vessel feeding, but development was arrested at the fourth or final phase and pupation did not as a rule take place. No food was supplied to the larvae, but they apparently found sufficient in the circulating water and on the sides of the vessel, where no doubt bacteria and fungi

* In the diagram the downward portion of this tube has been drawn much too long; the end (G) should be two inches above where it is shown.

were growing. No green growth appeared during my experiments. The larvae lived in this vessel a long time, often over twenty days, but in none of my experiments did a larva survive so long as 53 days, as one of Lima's is said to have done (Experiment XVI), although I do not think there was any reason why this should not have happened. The larvae with which I experimented almost always outlived the

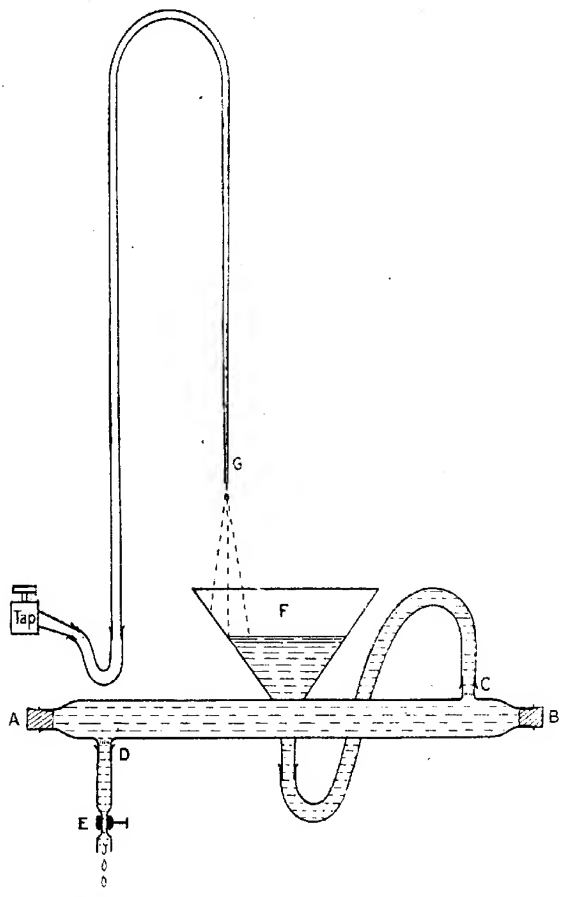

Fig. 1. Apparatus for keeping mosquito larvae entirely submerged in flowing water.

normal period for this state, and this being so, it seemed only a matter of chance how long they survived. In the case of larvae kept in jars and allowed free access to the air, the majority pass through this stage of development in a given period, but some having reached the fourth phase do not proceed to pupate. Such larvae live a very variable time, many die soon, but others survive a long time, and, as I have recorded

elsewhere (1915), may reach the hundredth day. The larvae kept in the vessel from which air was excluded behaved in an exactly similar way, and it seems probable that the reason why none survived for months was mainly due to the fact that a comparatively small number of specimens was used and a centenarian did not happen to be included.

In this system the larvae after a time became reconciled to the new conditions, appeared no longer to be anxious to find the air surface, and settled down to brousing along the sides of the vessel. It was thought possible that larvae thus habituated to a submerged existence might be unable to resume the normal method of breathing. One set of seven larvae of *Stegomyia fasciata* was therefore tested after four and a half days and the larvae were found to be still quite able to respire through the siphon tracheae. On being removed to a jar half-filled with water they quickly found the surface and attached themselves to it in a natural manner.

A few experiments were carried out with the larvae of two species of *Culex*, namely *C. fatigans* and *C. thalassius*. The larvae of *C. fatigans* did not survive a day in my experiments, but the larvae of *C. thalassius* seemed to be able to adapt themselves completely and lived a fortnight, at the end of which period they were removed for examination. It is of some interest that this species should be able to survive without access to air, as it possesses very small anal papillae, and it suggests that the oxygen absorption by submerged larvae of *C. thalassius* is mainly through the general cutaneous surface and only secondarily through the papillae. After a fortnight's submergence no change in size or structure could be seen in the anal papillae of these larvae.

Pupation of a submerged larva was observed only twice in all my experiments, once in the apparatus described above, and once in a gauze-capped tube immersed in a large vessel of water. On both occasions the pupa died immediately, and in one case it did not succeed in liberating itself from the larval pelt. The inability of the pupae to subsist by respiring only dissolved air is no doubt accounted for by the fact that they possess an impermeable cuticle.

My observations confirm those of Lima, to which reference has already been made. This observer experimented with the larvae of *Culex fatigans* and *Stegomyia fasciata*, as well as with other species that are not found on the Gold Coast. *C. fatigans* he found survived submergence but a short time, but *S. fasciata* was able to adapt itself to the unusual conditions and might live even so long as 53 days. The results of his experiments convinced him " that mosquito larvae, while generally breathing mainly free air by the two tracheae of the respiratory siphon, also respire the oxygen of the air dissolved in water, the gaseous exchanges being made by the branchial leaflets and also the general integument of the body."

Sen, using a different method, found that the " larvae rarely lived for more than 7 hours," and he therefore doubts the accuracy of Lima's results. His method was however questionable, in view of the fact already referred to that it is only a small proportion of the oxygen dissolved in water that is serviceable to the larvae.

Sen has criticised Lima's method of carrying out his experiments because bubbles occasionally appeared in the jars, and air might have been introduced, he thinks, with food particles, or by the agitation of the water when it was changed. The

method employed by me was not open to any of these objections, and yet I am able to confirm the statement that Sen regards as so remarkable, namely, that young larvae without any free air " grow and may even become nymphae."

The larvae of certain species of mosquitos, including *Stegomyia fasciata*, are undoubtedly capable of adapting themselves to a submerged life, and in this state continue to develop up to the point at which pupation would naturally take place. Pupation, however, is usually delayed, but if it does occur, the mosquitos die, since the pupae are unable to survive without direct access to free air. The practical bearing of this phenomenon would seem to be that it indicates one way in which mosquito larvae may escape the action of injurious substances applied to the surface of pools to kill them, and may explain why it is that "oiling" in practice is less successful than theoretically it should be. Many species of mosquito larvae spend a considerable part of their time at the bottom, and if on rising to breathe they are disturbed or find the surface unsatisfactory they often sink down to the mud and remain for a longer or shorter time in a quiescent condition. The majority of the larvae no doubt would be killed as a result of coming into contact with the oil, but some might escape, and the experiments recorded above prove that they would be capable, if necessary, of prolonging their submerged existence for a period long enough to allow the most liberal application of kerosene to evaporate.

The Results of "Oiling" with Crude Kerosene as observed in Laboratory Experiments.

Returning now to the question of the efficiency and general applicability of oiling, it may be of interest to record the results observed when crude kerosene was applied to fluids in which various species of mosquito larvae were living.

Anopheles costalis. The larvae of *A. costalis* do not survive for long the effects of oiling. In one experiment four larvae were placed in a jar containing a layer of tap-water 8 cm. deep. To the surface of the water, which measured 5 cm. by 10 cm., kerosene was added in a proportion equal to 10 cc. per square metre and the water agitated. Half an hour later the larvae were moribund, and in one hour they were all dead.

If the amount of kerosene added was more than enough to form a mere film, the larvae were apt to get caught by it when they came to the surface, and were apparently unable to free themselves. In these circumstances they lay on the surface wriggling feebly until they died, and the oil tended to collect in a thicker layer round their bodies.

Culex fatigans. The larvae of *C. fatigans* in laboratory experiments are also killed rapidly by the application of kerosene to the surface of the fluid in which they are living. In one experiment a single small drop of crude kerosene was added to each of nine small tubes of fluid 1·5 cm. in diameter in each of which a single fully developed *C. fatigans* was living. Eight of the larvae were found dead after half an hour, and the ninth after an hour.

The details have already been given (see p. 9) of another experiment with this species showing that the action of the kerosene on the larvae is a direct one and is not dependent on the solution of part of the oil by the fluid to which it is applied.

The siphon of the larvae of *C. fatigans* is of moderate length, four times as long as its basal diameter, but is much shorter than that of *C. invidiosus*. For this reason, perhaps, this larva does not seem to be in danger of being caught by the film of oil and dragged to the surface as is the larva of *C. invidiosus*. On examining the bodies of *C. fatigans* larvae that had died as a result of oiling, however, a globule of kerosene was often found adhering to the end of the siphon. There can I think be little doubt but that the larvae rising to the surface to breathe are unable to prevent the oil from entering the tracheal tubes in the siphon and being drawn into their bodies with fatal results.

Culex invidiosus. Five larvae of *Culex invidiosus* were included with the larvae of *Anopheles costalis* in the experiment recorded above. After half an hour they were all found floating on the surface in a moribund condition, and after an hour they were all dead. These larvae also are very liable to be caught by the oil and drawn to the surface in a horizontal position, and once this has happened, they appear to be unable to liberate themselves.

The larvae of *C. invidiosus* have long siphons, eight times as long as the basal diameter, and quite apart from any toxic action of the kerosene, they are unable to survive long without access to the external air. In one experiment by Sen's method five larvae of this species were submerged in tap-water. They were all found dead after half an hour.

Culex thalassius. The larvae of *C. thalassius* have been found at Accra and Christiansborg in the brackish water of lagoons, in fresh-water pools, and in old domestic utensils. They are not easily destroyed by oiling, and on one occasion in forwarding a sample containing this species the Medical Officer of Health, Accra, Dr. J. B. Alexander, stated that they were from a pool that had been regularly treated with kerosene. In a laboratory experiment in which the larvae were placed in small tubes containing 8 cc. of their natural medium, three fully developed individuals were still alive after 30 minutes, but were dead after one hour under a layer of kerosene 1 cm. deep, whereas three control larvae cut off from access to air by a layer of paraffin were found dead after 4, 5, and 6 hours respectively. The action of thin films of oil spread over larger volumes of water was similar.

When confined in similar tubes containing distilled water and covered with a layer of paraffin the larvae lived much longer, for example 26, 27, and 27 hours respectively in one experiment, and in the system simulating the natural conditions in a pool of water they survived many days and appeared to be quite at ease. It is not difficult therefore to understand how they may escape the larvicidal action of kerosene.

It is of some interest, as showing that the size of the anal papillae is no guide to ability to survive without access to air, that in the case of the larvae of *C. thalassius*, which are capable of subsisting so long on cutaneous respiration alone, these organs are very small. The papillae, however, are well supplied with tracheae. Larvae of this species are therefore susceptible to the action of kerosene oil when they come in contact with it, but they are capable of surviving a very long time without coming to the surface to breathe, and this power no doubt accounts for the fact that in actual practice they are not easily destroyed by "oiling."

Mansonioides africanus. The larvae of *Mansonioides africanus* usually obtain the oxygen they require by thrusting their siphon tubes, which are specially formed for

this purpose, into the roots of the water-weed, *Pistia stratiotes*, but in the laboratory they were sometimes seen to attach themselves in a similar way to other water-weeds also when *Pistia* plants were not available. They did not, however, survive long in the absence of *Pistia* plants, but when these were present they appeared to be quite at home in the laboratory and completed their development. They are not incapable of breathing air directly, but as a matter of fact they are seldom if ever seen at the surface unless they have been forcibly disturbed. In the absence of *Pistia* roots the larvae do not live long if prevented from reaching the external air. In experiments carried out by my standard method at laboratory temperatures, larvae in the first phase of development did not survive 20 hours in either their natural medium or in distilled water, and a single fully developed larva in distilled water survived 2 hours, but not 2½ hours. In jars in the laboratory larvae recently hatched attached themselves to the rootlets of the *Pistia* plants, and older larvae to the tap-roots, and as the result of actual experiments it was proved that they could moult and even pupate without having direct access to the external air.

It has been shown above that the larvicidal action is not dependent on any effects produced by solution of the oil. It is not surprising therefore that a layer of kerosene, no matter how thick, applied to the surface of water in which larvae of *M. africanus* were living attached to *Pistia* roots was found to be absolutely innocuous. In one such experiment a larva was kept under a film of oil corresponding to 100 cc. per square metre. After three days it was found to have pupated, on the sixth day the pupa appeared to be almost ready to hatch, and on the seventh day it was found dead at the surface. The oil in fact had no effect on the larva, and only acted on the pupa when it left the root of the water-weed preparatory to emergence.

Stegomyia fasciata. Some observations on the action of crude kerosene on the larvae of *Stegomyia fasciata* have already been recorded above. It has been shown (p. 9) that in a mass experiment in a natural fluid rich in organic matter there was no appreciable difference between the length of time the larvae survived under a layer of paraffin and under a layer of kerosene; and an experiment has been described (p. 4) in which some very young larvae were still alive after two days under an unbroken film of oil.

Two other experiments may be briefly mentioned. In the first, five *S. fasciata* larvae were placed in 400 cc. of tap-water and crude kerosene added in a proportion equal to 10 cc. per square metre. After 3½ hours one larva was found dead, two more died within the next twenty-four hours, but the remaining two were still alive and apparently unaffected when the experiment was ended on the fourth day. In the second experiment five larvae were placed in tap-water in a jar 7 cm. square, and kerosene added in a proportion equal to 200 cc. per square metre. Three days later one larva was still alive, although there still appeared to be a continuous film of oil over the surface of the water and the interior of the jar had a very strong smell of kerosene. On the fourth day this larva pupated.

When watching mosquito larvae imprisoned beneath a film of oil one cannot but be struck by the difference in the behaviour of *S. fasciata* and, for example, *C. fatigans*. The larvae of *C. fatigans* rising to breathe, as a rule, just touch the layer of oil, and then immediately sink down through the water again; or if they do adhere to the surface, remain more or less passive. Not so the larvae of *S. fasciata*. These larvae

on reaching the surface may often be seen to execute a series of short, rapid wriggling movements as if endeavouring to thrust the siphon forcibly upwards. This manoeuvre can most easily be watched when the water is covered by a layer of soft paraffin. It is then seen that the relatively short stout siphon first comes in contact with the paraffin with its valves closed. The larva, presumably aware that it has not reached the surface, then executes the strong wriggling movements mentioned above and the siphon appears to indent the paraffin and at the same time the valves are seen to open. So vigorous does the effort appear to be that it seems not improbable that it would effectually break through a thin film of oil, and as the valves are not opened until an appreciable time after the thrusting movement has started, there would probably be little risk of oil entering the tracheal tubes. It may sometimes happen, however, that when the film of oil is thick some does enter and this may account for the death of some larvae. When the oil is present in a definite layer, the larvae are of course unable to penetrate it and eventually give up the attempt and sink down through the water. They may then remain quiescent at the bottom for a time, but sooner or later they try again and continue to do this until they die either from lack of oxygen or from having at one attempt inhaled some kerosene. This suggestion is supported by the facts that under a deep layer of kerosene *S. fasciata* larvae survive in a natural medium rich in organic matter just about the same length of time as they do under a layer of paraffin, and that larvae often appear to be greatly irritated by the oil, are frequently seen apparently trying to remove it with their mouth-parts from the ends of the siphons, and that oil is often seen to be present at the ends of the siphons of larvae that have died under a layer of kerosene.

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MORPHOLOGICAL CHANGES OBSERVED DURING THE DEVELOPMENT OF THE LARVA OF STEGOMYIA FASCIATA.

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The larva of *Stegomyia fasciata* passes through four distinct phases after it emerges from the egg and before it pupates. Under circumstances favourable to growth these phases are passed through very rapidly and the whole larval stage may occupy less than a week. In one experiment ten larvae which had hatched from their eggs on 1st April between 12 noon and 2 p.m. were isolated singly in small glass tubes containing a three-days-old broth medium. All these larvae cast their first pelts on the second day (2nd April), their second pelts on the third day, and their third pelts on the fourth day. The fourth and last larval pelt was not cast simultaneously by all the larvae, perhaps because by this time the nutrient value of the medium in the different tubes had begun to vary to an appreciable degree. Two larvae cast the fourth pelt on the seventh day, one on the eighth day, three on the ninth, one on the tenth, and one on the thirteenth day, and two died in this phase. One pupa died, but all the others hatched on the second day after pupation. In this experiment therefore the larval stage lasted on the average nine days, the shortest time being under seven days, and the longest thirteen days.*

In the intervals between their moults mosquito larvae do not appear to undergo external morphological changes. Certain structures do become more highly chitinised in these periods, but speaking generally, the structure remains constant during each phase. In the course of development, however, the larvae of *Stegomyia fasciata* undergo marked morphological changes, and these can be followed in the case of individuals by an examination of the four pelts cast by each. This has been done in the case of the larvae used in the experiment mentioned above. The observations have been confirmed and extended by the examination of living larvae and of larvae killed and preserved at each of the four stages into which the larval period is divided. This was necessary, as it is not possible to measure, for example, the thoracic diameter or the length of the siphon of a young larva in the pelt, since these parts become distorted.

In the descriptions that follow the structures that show definite changes during the larval periods will be dealt with one by one, and subsequently the characteristics of each of the larval phases will be summarised. The unit employed in making the measurements was approximately 16μ (50 units = 0·8 mm.).

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*The eggs had been laid on 30th March, so that the period from the time the eggs were laid to the time when the adult mosquitos emerged ranged from 11 to 17 days and averaged 13 days.

Head (fig. 1). The large size of the head is a very noticeable feature of the larvae of the first phase, but later it is subordinated by the great development of the thorax. In the first phase the head was variable in shape; in some larvae it was rather broader than long, and measured about 16 by 17 units; in others it was longer than broad and measured about 14 by 10 or 11 units. In the second phase the head was as broad as it was long or broader, and in the third and fourth phases it was decidedly broader than long. The "egg-burster," situated dorsally about the middle of the head, is a conspicuous feature in the first phase (fig. 1, I).

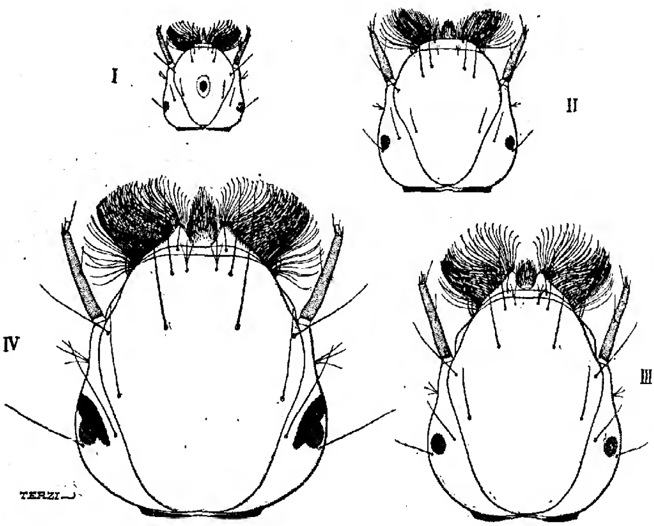

Fig. 1. Head of the larva of *Stegomyia fasciata* in the four stages.

Antenna (fig. 1). The antennae are relatively short and simple structures throughout the larval period. In the first phase they measured almost invariably 7 units, but in a few larvae they appeared to be half or one unit shorter; in the second phase they measured 8 to 10 units, but were most commonly 9; in the third phase 13 to 14 units, and in the fourth and last phase 18 to 20. They were straight in most larvae, but sometimes they curved slightly. The latter form was most frequently seen in the larvae of the first phase, especially in those that had long-shaped heads.

The second joint of the antenna is very poorly developed in the young larvae, but is somewhat larger and partly chitinised in the older individuals. Of the hairs at the tip of the antenna there is one which exceeds all the others in length, averaging 3 units in the first phase, about the same in the second, 3 to 4 in the third, and 4 to 5 in the fourth phase. The hair therefore increases slightly in length as the larva matures, but its growth is not proportional to the growth of the antenna.

The antennal plume is much reduced. In the earliest phase it is represented by a double sub-plumose hair, but in the three later phases by a single short simple hair; very occasionally a double hair may be present in the second phase. The position of this plume is somewhat variable, and is not always the same on the two sides of the head. In the first phase it was situated at 2 or, more usually, 3 units from the base of the antenna, in the second phase 4 or 5 units, in the third phase 6 to 8 but usually 7 units, and in the last phase 10 to 14 units. That is, as the larva develops the position of the plume shifts slightly from just below to a little above the middle point.

The shaft of the antenna bears a considerable number of minute spines in the earliest larval stages, but these are very few in the third phase, and are apparently completely absent in the last phase.

Eyes (fig. 1). The eyes were small and rounded in all the larvae examined. Their approximate diameter was 1½ units in the first phase, 3 or a little more in the second, 3 to 4 in the third, and 4 to 5 in the fourth. In the youngest larvae they could sometimes be seen to be made up of several pieces, generally three. In the fourth phase a rather less dense patch of pigment lay like an eyebrow in front of the darker and denser circular patch of the eye; this was the so-called "main" eye, the organ which is said to become the compound eye of the imago.

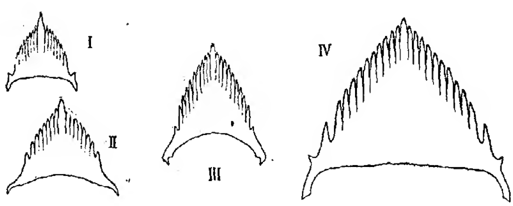

Fig. 2. Labial plate of the larva of *Stegomyia fasciata* in the four stages.

Labial Plate (fig. 2). The number of teeth on each side of the large median tooth of the labial plate showed slight individual variations, but much greater developmental changes. In the first phase there were 7 or 8 teeth, in the second 9 or 10, in the third 10 to 12, and in the fourth 13 to 14. In the later stages the labial plate was much more highly chitinised than in the earlier, but in each phase it conformed to the typical plan, a triangular body with a large median tooth at the apex, and smaller teeth down each side, those nearest the median tooth being smaller and more closely set than those further away.

Thorax. The thorax is at first very small, but increases rapidly in size and in proportion to the other parts of the body as the larva matures. In the first phase the diameter of the thorax is less than or about the same as that of the head, namely, about 10 to 13 units. In the second phase the thorax and head are about equally broad, but by the time the third phase is reached the thorax is definitely the broader, the ratio in one larva being for example 53 : 42, and in the fourth phase it is broader still, the ratios in two larvae being 75 : 55, and 90 : 55 respectively. The breadth of the thorax is a conspicuous feature of the mature larva.

The two pairs of ventral hooks (fig. 3) increase in size and in the degree to which they are chitinised as the larva grows. In the first phase they are hardly chitinised at all, and are represented merely by four minute sharp-pointed structures. With each moult the hooks enlarge and strengthen, until in the last phase they assume the formidable appearance so familiar in these larvae.

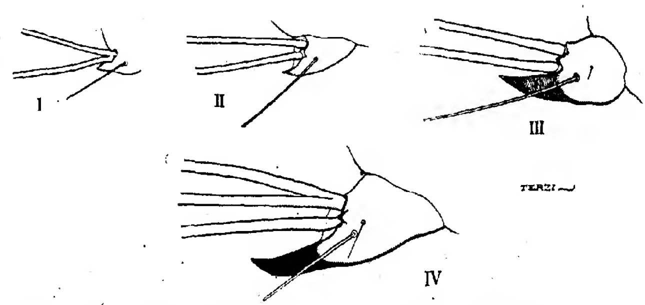

Fig. 3. One of the ventral thoracic hooks in each of the four stages of the larva of *Stegomyia fasciata.*

The arrangement of the hairs clearly indicates the three segments of the thorax at each stage of the development. The hairs increase in size, strength, and complexity as the larva grows, and their subplumose structure, which in the first phase is all but invisible, becomes more marked. The anterior dorsal plumes appear to be absent throughout the larval period.

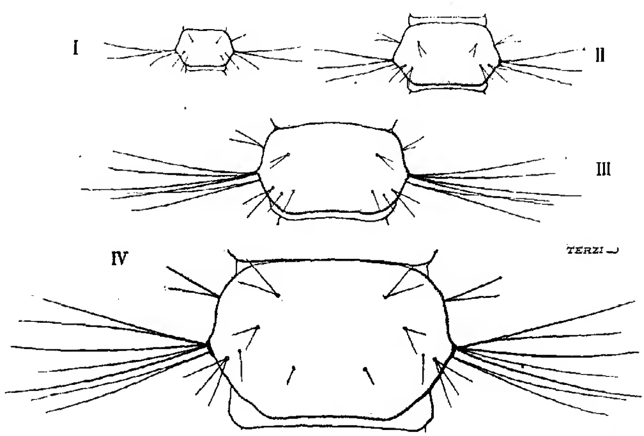

Fig. 4. Larva of *Stegomyia fasciata*; the second abdominal segment in the four stages.

Abdomen. The hairs on the abdomen are not very numerous and are mostly small and simple, but a few little triple hairs (stellate hairs) are also present, and some long conspicuous hairs (fig. 4). In the first phase the long hairs are double, and are with

difficulty seen to be not quite simple; in later phases they are sub-plumose and may be subdivided into a number of branches. In the first three phases these long hairs are found on the first five segments, those on the earlier segments being the longer and stronger; in the last phase they are present on the first eight abdominal segments, those on the first and second segments having several branches, those on the third and fourth being triple and those on the other segments being double. The degrees of division of the hairs is, however, variable.

The siphonal, sub-siphonal, and anal plumes are all single simple hairs in the first phase, but in subsequent stages they undergo division, this being especially marked in the case of the sub-siphonal plume, which in the fourth phase may be composed of certainly six sub-plumose branches.

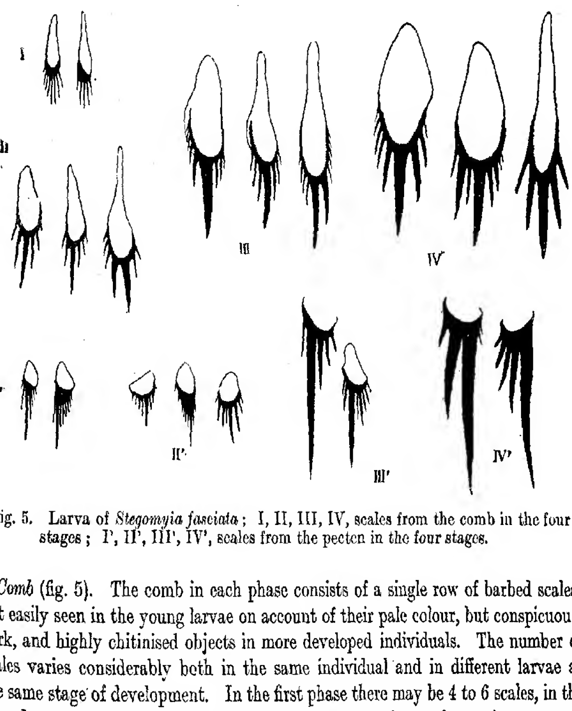

Fig. 5. Larva of *Stegomyia fasciata*; I, II, III, IV, scales from the comb in the four stages; I', II', III', IV', scales from the pecten in the four stages.

Comb (fig. 5). The comb in each phase consists of a single row of barbed scales, not easily seen in the young larvae on account of their pale colour, but conspicuous, dark, and highly chitinised objects in more developed individuals. The number of scales varies considerably both in the same individual and in different larvae at the same stage of development. In the first phase there may be 4 to 6 scales, in the second 8 to 10, in the third and fourth about the same number, and sometimes as many as 12. The most notable change is that which occurs at the time of the first moult, when the number of scales doubles, and in later phases, although the number may remain constant, it does not again return to that found in the first phase.

In addition to an increase in size and strength, the individual scales undergo a change of form during development. At every stage they bear numerous barbs, the number varying greatly, both according to the individual and to the position of the scale in the

comb. The general form remains nevertheless fairly constant in each phase, and the most conspicuous development observed to take place was a lengthening and general enlargement of one of the central barbs until it became an outstanding feature.

Siphon (figs. 6, 7). In four larvae belonging to the four phases the lengths and breadths (at the base) of the siphons were respectively 12 by 5, 19 by 8, 37 by 16, and 46 by 30 units. In the first three phases therefore the length of the siphon was rather over twice its basal diameter, but in the last phase it was considerably less than this. In the last phase practically the whole of the siphon is chitinised and is therefore little liable to distortion. The averages of length and breadth of the siphon in ten such larvae taken at random were respectively 49·4 and 29·9 units, a proportion equal to 1·65 to 1.

It is generally stated that the length of the siphon of *Stegomyia fasciata* is more than twice its breadth, and this character has been made use of for the identification of this species in the larval stage. It is important to realise that this statement is not strictly accurate in the case of larvae in the last phase of their development, and in some individuals in their earlier phases also.

It is characteristic of *Stegomyia fasciata* that the young larva has only the tip of the siphon dark-coloured. The dark part of the siphon is of course the chitinised part, and this increases in proportion as the larva matures. The larva immediately after emerging from the egg has no part of the siphon dark, but during the first phase the tip becomes chitinised for from 4 to 6 units of its length. The chitinised part measures 9 to 13 units in the second phase, 25 to 31 in the third, and 43 to 50, or practically the whole length, in the fourth phase.

Pecten. The pecten consists of a single row of scales running nearly parallel to the sides of the siphon. The last scale is sometimes detached from the others, and sometimes there is a scale situated to one side of the general rank.

The number of scales is variable both in the same individual on its two sides, and in different larvae at the same stage of development, but it increases rapidly with successive moults. In the first phase there are usually 4 to 5 scales, in the second 8 to 10, in the third 12 to 18, and in the fourth 14 to 20. In some individuals the number of scales increases progressively, for example the successive pelts cast by one larva showed respectively 4, 8, 16, and 19 scales; in others the maximum number may be reached in the third phase as occurred in a larva which showed in the four phases 5–5, 9–8, 18–15, and 18–15 pecten scales. Each scale has a variable number of barbs and, as in the case of the comb, the most notable changes observed during development are the strengthening of the scales, and the differentiation of one barb into a long and conspicuous process (fig. 5).

Hair-tuft on the Siphon (figs. 6, 7). The hair-tuft on the siphon is usually situated just beyond the last scale of the pecten, that is in the first phase 6 to 11, in the second 10 to 18, in the third 22 to 25, and in the fourth 25 to 31 units above the base, but sometimes it lies on a level with one of the last scales. It consists of a single simple hair in the first phase, usually a double but sometimes a triple hair in the second phase, a triple hair in the third phase, and a hair with 3 to 5 branches in the fourth phase. The position of the hair-tuft is in every phase a little beyond the middle of

the siphon. The ratio of the distance between the hair-tuft and the base to the total length of the siphon worked out at approximately 1 to 1·7 in all the larvae examined at each stage.

There are in addition a few simple short hairs on the siphon near to the tip. These are most conspicuous in larvae in the first phase, and at this stage two, one on each side of the siphon and curving inwards, are longer than the others.

Anal Segment (figs. 6, 7). The anal segment is short, at first slightly longer than broad, but in the last phase often broader than long. The part chitinised is at first only a small saddle-shaped area, but in the last phase practically the whole segment is more or less chitinised. In the first phase this area measures 5 to 6 units in length, but only about 2 units in breadth, in the second phase 8 or 9 by 5 or 6, in the third phase 13 or 14 by 7 or 8, and in the fourth phase 16 to 20 by 17 to 22 or more.

The dorsal edge in all the stages carries a number of long hairs at its distal end (see below), and there are some similar hairs on the ventral edge, and a poorly developed beard, in the last three phases.

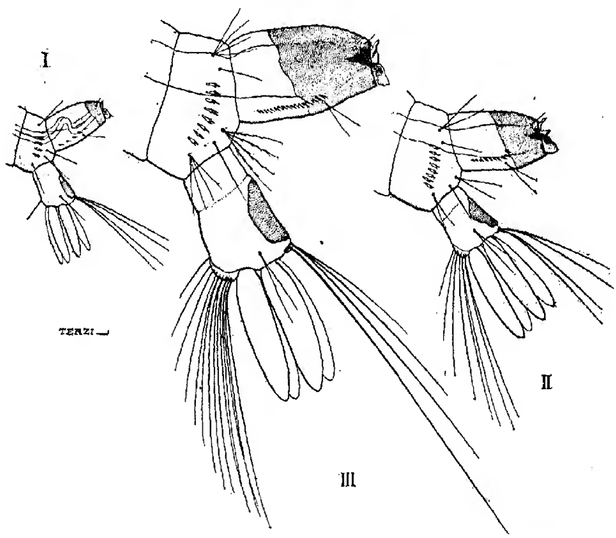

Fig. 6. Larva of *Stegomyia fasciata*; posterior end in the first three stages.

Anal Papillae (figs. 6, 7). The four anal papillae are about equal in length in each phase of the larval period, but increase in all dimensions as the larva matures. In four individuals belonging to the four phases they measured respectively 9, 17, 35, and 58-64 units in length, and in these same larvae the lengths of the anal segments were 7, 10, 22, and 18 units. The papillae vary a good deal and are liable to be affected by fixation, as might be expected of such delicate structures, but in the earlier phases they are certainly less than twice as long as the anal segment. They taper

somewhat at both ends, and although the distal ends are rounded, they can hardly be said to be "strikingly blunt" during life or in recently preserved specimens. The ratio of length to breadth is usually 5 to 1.

In the last phase a number of highly refractile discs become conspicuous in the papillae. These are the nuclei of the delicate tissue of which these organs are composed, and they can readily be brought out by staining with haematoxylin. The presence of these nuclei is not of course peculiar to this phase, but they are more obvious and more likely to attract attention in unstained specimens at this time than in the earlier phases.

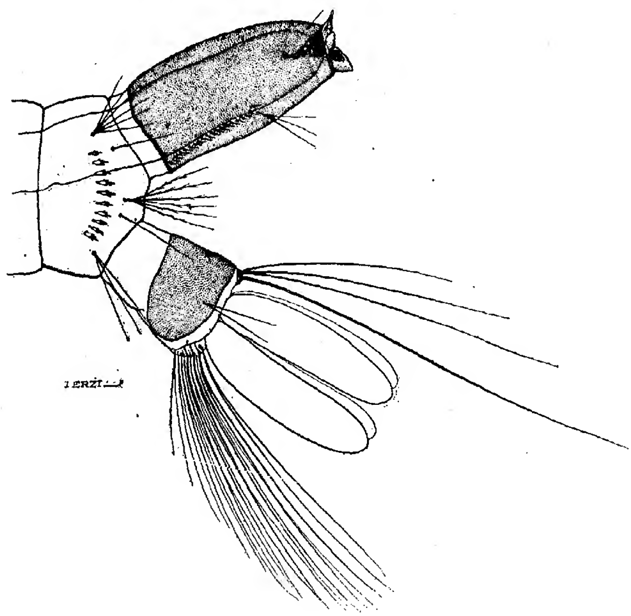

Fig. 7. Larva of *Stegomyia fasciata*; posterior end in the fourth stage.

Dorsal Hairs on the Anal Segment (figs. 6, 7). On the dorsal edge of the anal segment there are four long hairs which were described by Wesché (1910)* as simple, and by Boyce (1911)† as bifurcated. As a matter of fact the character of these hairs varies with the age of the larva. In the first and second phases in every larva examined they were simple; in the third phase the two more dorsal hairs were bifurcated, but the two ventral ones remained simple; in the fourth or last phase the hairs had undergone greater subdivision, the dorsal pair being divided into from 3 to 5 parts each, and the ventral pair being usually bifurcated, but sometimes remaining simple. In this last phase the number of hairs was very variable, some-

* Wesché, W. Bull. Ent. Res., Vol. I, p. 25.
† Boyce, Sir R. Bull. Ent. Res., Vol. I, p. 244.

times reaching 13 (5, 2; 5, 1) and sometimes being as few as 9 (3, 2; 3, 1); but although there is no reason to suppose that these are the limits of variability, it should be stated that in none of the larvae examined at this stage did the number fall as low as that found during the third phase, namely 6 (2, 1; 2, 1). In proportion to the size of the larva the hairs are very much longer in the first phase than they are later.

These then were the more important morphological changes observed to occur during the development of the larva of *Stegomyia fasciata*. Some previous descriptions, as for example that of Wesché, would appear to have been pieced together from observations made on larvae of different ages, and for this reason it may be as well to summarise the more prominent features characteristic of the larva at each of the four phases of its development.

First Phase.

During the first phase the larva is a minute whitish body. The antenna is 7 units long, and bears in place of a plume a double sub-plumose hair at a point just below the middle; the shaft is studded with minute spines. The labial plate has 7 or 8 teeth on each side. The thorax is narrower than or about the same width as the head, and the two pairs of ventral hooks are quite rudimentary. The comb consists of 4 to 6 scales. The length of the siphon is rather more than twice its basal diameter, and the hair-tuft, a single simple hair, is situated a little beyond the middle; only the extreme tip of the siphon is chitinised. The pecten is composed of 4 or 5 scales. The anal segment is slightly longer than broad, and a saddle-shaped dorsal patch is chitinised. The anal papillae are slightly longer than the anal segment. There are four simple hairs on the dorsal edge of the anal segment, but no ventral hairs or beard.

Second Phase.

In the second phase the antenna is a little longer, about 9 units, and the plume, which is close to the mid-point, is reduced to a single simple hair; there are some little spines on the antenna, but fewer than there are in the first phase. The labial plate has 9 or 10 teeth on each side. The thorax is about the same width as the head and the thoracic hooks are better developed. The comb comprises 8 to 10 scales. The siphon is a little more than twice as long as broad, its tuft a double or triple hair, and its end rather more extensively chitinised. The pecten is made up of 8 to 10 scales. The anal segment is about as long as it is broad, and is rather more highly chitinised. The papillae are less than twice as long as the anal segment. The dorsal hairs on the anal segment are still simple, but there are now some ventral hairs and a rudimentary beard.

Third Phase.

At this stage the larva is both darker in colour and more highly chitinised. The antenna remains much the same but is longer, 13 to 14 units, and there are very few spines on the shaft. The labial plate has 10 to 12 teeth on each side. The thorax is considerably broader than the head, the ventral thoracic hooks being well developed. The comb has about the same number of elements as in the second phase, but the scales are more highly developed. The siphon is about twice as long as broad, and

about three-quarters of it is chitinised, the hair-tuft beign triple. The pecten is composed of 12 to 18 scales. The anal segment is more extensively chitinised, and the relative length of the papillae remains about the same. The dorsal hairs on the anal segment have now begun to subdivide, the dorsal pair being usually bifid in this phase.

Fourth Phase.

In the final phase the length of the antenna is 18 to 20 units; the plume, a single simple hair, is situated just above the middle point, and there are no spines on the shaft. The labial plate has 13 or 14 teeth on each side. The thorax is much wider than the head, and the ventral hooks are large and powerful. The number of scales in the comb varies from 8 to 12. Practically the whole length of the siphon is chitinised, the length being rather less than twice the basal diameter. There are 14 to 20 scales in the pecten. The hair-tuft on the siphon has 3 to 5 branches. The anal segment is highly chitinised, and is often broader than long. The papillae are at this stage more than twice as long as the anal segment. The four hairs on the dorsal edge of the anal segment are more freely subdivided, the dorsal pair having from 3 to 5 branches, and the ventral being usually bifurcated. The sub-siphonal plume is made up of several sub-plumose branches.

* * * *

Since such marked morphological changes occur during the larval stage it is hardly necessary to point out that for purposes of identification the phase of development to which the larvae have attained must be known. The first phase is a brief one, and could only be secured by hatching eggs, and the second and third phases are only transitional and are not always easy to identify by a superficial examination. It would therefore be best for purposes of classification to deal only with larvae in the last phase, the fourth, and these fortunately are always easy to recognise.

Certain characters are constant throughout the larval period, such as the short and simple antenna with a rudimentary plume, the presence of a comb consisting of a single row of scales, the rather short and stumpy siphon with a well developed pecten and a small hair-tuft a little beyond its middle point, and the presence of long anal papillae with bluntish ends. These one may suppose to be very old and well established characters.

The morphology of other features seems to undergo a regular and progressive development as the larva matures. For example, the antennal plume moves slightly but regularly upwards in successive phases; the spines on the shaft of the antenna are gradually reduced; the longest of the hairs at the end of the antenna grows relatively shorter; the teeth on the labial plate increase in number; the thorax broadens until it is much wider than the head; the ventral thoracic hooks grow larger and more powerful; the siphonal, sub-siphonal, and anal plumes subdivide; the number of scales in the pecten increases; the anal segment becomes broader; the anal papillae double in length at each moult, and the hairs on the dorsal edge of the anal segment subdivide. It is features such as these that in their final form one might expect to be characteristic of the species, and from amongst them one might be able to select some that would be useful for identification.

In addition, there are a few characters which are peculiar to the earliest phases. There is for example the double sub-plumose hair, representing the plume on the antenna in the first phase only; the 4 to 6 elements in the comb, which changes to 8 to 10 in the second phase and may thereafter remain unchanged until the end of the larval period; and the simple formula for the hairs on the dorsal edge of the anal segment, only found in the first and second phases. It is possible that some of these perhaps indicate some earlier stage in the evolution of the species. For if in the development of the individual the evolutionary history of the species is recapitulated, one might expect to find in the larval phases of *Stegomyia fasciata* some indications as to the other species and genera of mosquito most nearly related to it. To do this it would be necessary to study the changes found in successive larval phases in other mosquitos and to compare them with those observed in this species. This cannot be done at present, as, so far as I am aware, the changes that take place during the larval period have not been completely recorded in the case of any other African species. A comparative study of this sort might, however, be of great assistance in formulating a natural system of classification.

COLLECTIONS RECEIVED.

The following collections were received by the Imperial Bureau of Entomology between 1st July and 30th September, 1916, and the thanks of the Managing Committee are tendered to the contributors for their kind assistance :--

Dr. W. M. Aders :—282 Culicidae, 12 other Diptera, 2 Microlepidoptera, 8 Ants, and 4 Mollusca ; from Zanzibar.

Dr. W. Allan :—63 Mosquito larvae and pupae ; from Sierra Leone.

Captain C. H. Armitage, C.M.G., D.S.O., Chief Commissioner :—8 Culicidae, 2 Tabanidae, and 2 Muscidae ; from the Northern Territories, Gold Coast.

Mr. G. E. Bodkin, Government Economic Biologist :—5 Hippoboscidae, 16 other Diptera, 1 Chalcid, 85 other Hymenoptera, 29 Coleoptera, 4 Lepidoptera, 2 Planipennia, 2 Mallophaga, a number of Coccidae, 11 other Rhynchota, 8 Orthoptera, 1 Tick, 1 Centipede, and 3 worms ; from British Guiana.

Mr. I. H. Burkill, Director of the Botanic Gardens, Straits Settlements :—3 Weevils, attacking orchids ; from Penang.

Mr. E. C. Chubb, Curator of the Durban Museum :—94 Diptera, 3 Coleoptera, and 17 Rhynchota ; from Natal.

Mrs. A. Connal :—89 Culicidae ; from Lagos.

Mr. M. T. Dawe, Director of Agriculture :—15 larvae of *Dermatobia hominis*, 10 Tabanidae, about 30 Bees, about 150 Termites, 4 Weevils, 22 Rhynchota, 2 Orthoptera, and 84 Ticks ; from Colombia.

Mr. D'Emmerez de Charmoy, Government Entomologist :—27 Diptera, 9 Hymenoptera and 2 Hymenopterous pupa-cases ; from Mauritius.

The Division of Entomology, Pretoria :—4 Diptera, 18 Hymenoptera, 58 Coleoptera, 8 Rhynchota, and 9 Orthoptera ; from South Africa.

Mr. P. R. Dupont, Curator of the Botanic Station, Seychelles :—3 Mosquitos, 33 Hymenoptera, 69 Coleoptera and 9 larvae, 44 Lepidoptera and 5 larvae, 1 Ant-lion, about 100 Termites, 20 packets of Coccidae, 25 other Rhynchota, 12 Orthoptera, 7 Odonata, and 12 Crustacea ; from various islands in the Indian Ocean.

Mr. C. O. Farquharson, Government Mycologist, S. Nigeria :—31 Ants ; from Aberdeenshire.

Mr. T. Bainbrigge Fletcher, Imperial Entomologist :—215 Weevils ; from India.

Mr. C. C. Gowdey, Government Entomologist :—11 Diptera, 38 Chalcids, 11 other Hymenoptera, 92 Coleoptera, 19 Lepidoptera, 2 spp. of Coccidae, about 100 Aphididae, 51 other Rhynchota, 5 Thrips, 2 Lice, 12 Mites, 1 Centipede, and 1 Worm ; from Uganda.

Mr. Gerald F. Hill, Government Entomologist :—5 Diptera, 2 spp. of Coccidae, 5 other Rhynchota, and 1 Cockroach ; from the Northern Territory of Australia.

The Director of the Imperial Institute :—2 Coleopterous larvae.

Dr. J. W. Scott Macfie, W.A.M.S. :—325 Mosquitos, 30 larvae and 1 pupa, 25 other Diptera, 1 Eumenid wasp, 36 Lepidoptera, 2 Myrmeleonidae, 2 spp. of Coccidae, and 1 Tick; from the Gold Coast.

Dr. L. Péringuey, Director of the South African Museum :—17 Diptera, and 20 Chalcids; from Cape Colony.

Mr. A. H. Ritchie, Government Entomologist :—1 Tachinid fly, 51 Chalcids, 42 other Hymenoptera, 117 Coleoptera, 5 Moths, 9 lots of Coccidae, and 35 other Rhynchota; from Jamaica.

Mr. N. Sacharov :—1,041 Coleoptera, and 128 Locusts; from European Russia.

Dr. J. J. Simpson :—6,465 *Glossina*, 143 other Diptera, 7 Chalcids, 18 other Hymenoptera, 126 Coleoptera, 2 Lepidoptera, 6 Rhynchota, and 1 Locust; from the Northern Territories, Gold Coast.

Dr. Wu Lien Teh :—9 Tabanidae; from Manchuria.

Dr. Francis Watts, C.M.G., Commissioner of Agriculture :—26 Diptera and 1 tube of larvae, 23 Chalcids, a large number of Braconids and their cocoons, 6 Wasp nests, 16 other Hymenoptera, 2 tubes of Weevils, about 85 other Coleoptera, 1 box of Hawk Moths, 74 other Lepidoptera, 1 tube of Lepidopterous larvae, 222 Rhynchota, and 1 Grasshopper; from the British West Indies.

Mr. Rodney C. Wood :—12 *Phlebotomus*, about 30 Hippoboscidae, 230 other Diptera, 10 Fleas, 10 Lice, 12 Ticks; from Nyasaland.

NOTES ON COCCID-INFESTING CHALCIDOIDEA.—III.

By James Waterston, B.D., B.Sc.,
Imperial Bureau of Entomology, London.

Like the preceding instalment, this part deals mainly with species bred on the West Coast of Africa. I have to thank Dr. L. Masi, of Genoa, for fig. 4, illustrating the wing base of *Eusemion italicum*, Masi.

Coccidoxenus distinguendus, sp. nov.

♀: A blackish-brown species; vertex very dark metallic blue between the punctures, but narrowly gleaming in the front of the occipital edge. Antennae pale brownish, the funicle a little infuscated dorsally towards the apex, the sixth joint darker and the club distinctly so. Thorax: mesonotum metallic dark blue-green, dully shining before the scutellar suture, the scutellum from above dull, nearly black medianly, but the sides are shining metallic (see notes on sculpture). Propodeon and abdomen non-metallic. Wings like those of *C. obscuratus*, but the median cloud is darker, and the apex also beyond the lunar clear band is clouded, though not so darkly as the middle of the wing. Legs, from coxa to apex of femur blackish brown, the knees narrowly paler (very obscurely so in hind legs), fore tibiae pale, a little infuscated basally and along the dorsal and ventral edges, mid and hind tibiae dark with the apices broadly paler; tarsi pale, the fifth joint, claws, and empodia of all the legs a little darker.

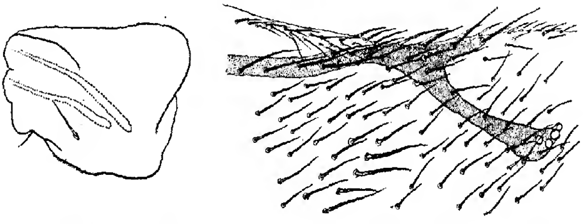

Fig. 1. *Coccidoxenus distinguendus*, sp. n., ♀; mandible and details of neuration.

Head (9 : 8). Eyes occupying five-ninths of the depth, seen from in front, large, with the orbits for one-quarter of the depth of the head below the anterior ocellus parallel (whereas in *coelops* and *obscuratus* the orbits diverge from that point). Toruli very distinctly below the base line of the eyes, separated by just over their length from the mouth-edge and one and a half lengths apart. Intra-torular area and clypeus flat. Puncturation moderate, coarsest along the orbits and on the vertex but much finer than in *obscuratus*; between the orbits, the anterior ocellus and the toruli, the surface is unpitted though rough; towards the genal keel the integument may be described as coriaceous.

Mouth-parts. Labrum almost as in *obscuratus* but a little narrower (1 : 5). The epipharynx (2 : 3) is oblong in both species, but longer (6 : 7) in *obscuratus*. Mandibles (fig. 1) of the same proportions as in *obscuratus*, tridentate, the teeth short

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and broad, the middle one most prominent. In the maxillary palpus (20, 17, 15, 36) the fourth joint (3 : 1) is rather long. On the galea are, in all, about 40 external bristles, 15–16, apically stronger (in *coelops* nearly 60, in *obscuratus* upwards of 70 bristles).

Thorax. Pro- and meso-nota up to the suture regularly, rather finely transverse reticulate—the cells hardly raised. Mesonotum with about 100 bristles, which increase in size and are sparser towards the suture. The axillae (10 bristles), the mid-anterior half and a small pre-apical spot on the scutellum still with a fine reticulation, but the cell-walls much raised and refringent. Especially posteriorly, the cells on each side run together into long, thin ridges (about 12 deep) whose optical effect is a beautiful silky lustre. There are about 24 (12, 12) short bristles on the anterior half of the scutellum and about half that number widely spaced towards the apex where there are placed two approximated median bristles. Mesosternum medianly with a fine, raised pattern; pleurae smooth, with an extremely fine, close striation, a little coarser posteriorly.

Wings. Forewings, length 1·4 mm., breadth ·56 mm., 2½ times as long as broad, a little narrower than in *obscuratus*. The submarginal vein is very long, over 8 times the marginal, and about 5 times the slender radius. Marginal : radius : postmarginal, in the ratio 8 : 14 : 5. The postmarginal is thus a little longer relatively than in *obscuratus*, and the angle it makes with the radius is more acute than in either *obscuratus* or *coelops*. The submarginal vein with 12 bristles (18 in *obscuratus*); the 4 long apical inferior bristles on the submarginal cell are all closer set, otherwise the chaetotaxy round the marginal, etc., closely agrees with that of *obscuratus*, except that in the latter species there are more bristles beyond the radius (fig. 1). Behind the submarginal vein is a complete row of short bristles, mainly coloured (2–3 beyond the middle of the submarginal, hyaline); behind this row again is an incomplete row of 4–5 bristles (in *obscuratus* about 3 complete rows), thence to the hind edge of the wing bare (about a dozen hyaline bristles in *obscuratus*). On the edge of the patch of bristles below the marginal and uprise of the submarginal proximally and posteriorly are about 20 weak hyaline bristles (70–80 in *obscuratus*). Hindwings narrow, length ·93 mm., breadth .26 mm., about 3½ times as long as broad (3 in *obscuratus* and *coelops*); 9 minute bristles in submarginal cell and 6–7 at the hooks.

Legs. Fore-legs with coxa slightly narrower than in *C. obscuratus* and bearing posteriorly and subdorsally above the trochanter a patch of only 10 short bristles (26–28 in *coelops* and *obscuratus*). In the tarsus the first joint is longer than the fifth (7 : 6). In the mid legs the tibia bears anteriorly on the apical edge 8 peg-like spines, and there are on the first four tarsal joints respectively 19, 10, 10, 7, similar spines (in *obscuratus* 32, 13, 12, 9–10). The tarsus is moderately bristly, *e.g.*, on the posterior aspect of the first joint there are about 5 longitudinal rows of bristles containing in all about 50, while 12–13 of the plantar bristles are spinose (in *obscuratus* about 70, and 15–16; in *coelops* about 30, and 12–13). In the hind leg the tibia is distinctly narrower (70 : 9) than in *coelops* (57 : 9) or *obscuratus* (65 : 10). The comb contains 16–17 spines and 10 of the plantar spines (single or double) are stronger (13–15 in *coelops* and *obscuratus*).

Abdomen. The second tergite bears on each side a narrow belt of small refringent cells. The fifth sternite broad, acuminate, with a slight, minutely bilobed apical furrow; on each half of the sclerite there are about 45 bristles—20 more minute towards the base, the remainder mainly on the distal half.

Length, over 1·6 mm.; alar expanse, about 3½ mm.

GOLD COAST: Aburi; (*a*) reared from female of *Lecanium* sp. on coffee, 19. xii. 15, 2 ♀♀; (*b*) reared from *Lecanium subhemisphaericum* Newst., sp.n.,* on coffee, 27. xii. 15, ♀ (*W. H. Patterson*).

Type ♀ in the British Museum (one of the pair (*a*) noted above).

The species of *Coccidoxenus* appear to be numerous and closely related to one another. The species just described should be known at once by the mandibles, but unfortunately in few of the extant descriptions of members of the genus are the mandibles referred to at all.

Aëthognathus afer, Silv.

Aethognathus afer, Silvestri, Boll. Lab. Portici, ix, 1915, p. 352, figs. 13–14. Described from Aburi, Gold Coast, the host being *Stictococcus diversiseta,* Silv.

Aëthognathus afer, var. **cavilabris,** nov.

♂♀. Generally darker (distinctly blackish) than the West African race, from which it differs little superficially except in the slightly coarser puncturation of the vertex, *e.g.*, in *afer* there are about 8 punctures between the posterior ocelli (6 in v. *cavilabris*) and 16 along the occipital edge (12 in v. *cavilabris*).

UGANDA: Entebbe, from *Stictococcus dimorphus,* 9.viii.1912, 2 ♂♂, 9 ♀♀ (*C. C. Gowdey*).

Type ♀ in the British Museum.

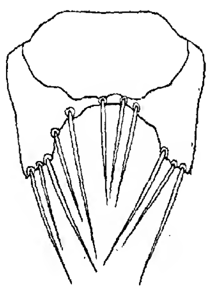

Fig. 2. *Aëthognathus afer,* Silv., var. *cavilabris* nov.; labrum of ♀.

I had determined the above material as *A. afer,* but on making complete dissections found that the labrum (fig. 2) in both sexes lacked the conspicuous median lobe of the West Coast form (*loc. cit.* fig. xiv, 4). Professor Silvestri tells me that additional dissections of the type material prove that the difference is

* See below p. 363.

constant. At present it seems best to consider the Eastern and Western forms as local races of one species. Besides the differences already noted there appear to be others in the ratio of the antennal joints; *e.g.*, the club of the antenna is relatively longer in typical *afer* than in the var. The lighter coloration of the Aburi examples may be due in part at least to preservation in alcohol. Through the kindness of Professor Silvestri a cotype of *A. afer* has been presented to the Imperial Bureau of Entomology, and a cotype of var. *cavilabris* has been deposited at Portici.

Genus EUSEMION, Dahlb.

Eusemion, Dahlbom, Oefv. Svensk. Vet.-Akad. Förh., xiv, 1857, p. 293.

Although considered by Mayr to be equivalent to *Cerapterocerus*, Westw., this group probably deserves separate treatment. It is distinguished by the rather broad sub-triangular wing, the large single cloud, and the neuration, the marginal being rather long, and the postmarginal and radius, though short, both distinctly developed.

Eusemion cornigerum, Walk.

Encyrtus corniger, Walk., Ent. Mag., 1838, p. 114.

♀. Blackish brown; antennae, especially on the scape, with a slight cupreous gleam; eyes dark chocolate; vertex and upper frons refringent, dark metallic green. Thorax slightly darker than the abdomen, with at most a trace of metallic reflection (greenish) apically or marginally towards the apex. Wings with the veins blackish brown, pattern as in fig 3, *a*, the cloud being darkest immediately behind the costa between the postmarginal and the apex of the wing. Legs with all the fifth tarsal joints, claws, and empodia darker; remainder of the tarsi, apices of tibiae (broadly) and the spurs pale, otherwise nearly as dark as the abdomen and nowhere metallic.

Head very much wider than deep across the lower face (17 : 14); eyes in profile occupying four-sevenths of the depth. Vertex slightly broader than in *E. pattersoni*, Waterst. (two-ninths the width of the head). Ocelli in an isosceles triangle so short as to be almost equilateral; posterior pair nearer to one another than to the anterior ocellus, and separated from the margin of the vertex by little more than their own length. Between the anterior ocellus and the edge of the frontal flattening there are four rows of punctures, the middle pair containing 5–6 large and conspicuous ones; along the orbits the rows are obscure and consist of smaller, less conspicuous punctures. Toruli oval, sub-reniform in shape, the opposed edges being flatter and a little concave medianly. Genal striae rather coarse, 4 bristles above the genal edge. Between and above the toruli are about 16 bristles.

Mouth-parts. Labrum distinctly concave, with 8 bristles. As the upper margin of the chitinised area is also concave, the dissected labrum has the shape of a bi-concave lens. Mandibles (7 : 5) tridentate (fig. 3, *d*). Maxillary palpus 15, 10, 10, 21; in same ratio the breadths are 5½, 7, 6, 9. There is a strong bristle on the stipes well before the palpus and two shorter (median) on the mentum.

Antennae (fig. 3, *b*, *c*). The pedicel though compressed is almost normal, and the club is much more distinct from the funicle than in either *E. pattersoni* or *E. italicum.*

Thorax. Reticulation of the mid lobe as coarse as that of the scutellum generally and coarser along the mid line. Bristles much fewer than in *pattersoni* (*e.g.*, in front of the suture there are in *pattersoni* about 12, in *cornigerum* about 6 bristles); on the scutellum also the bristles are fewer (about 7 or 8 on each side of the mid-line, 20 : 20 in *pattersoni*) and the sensory pustules are at one-third from the hind

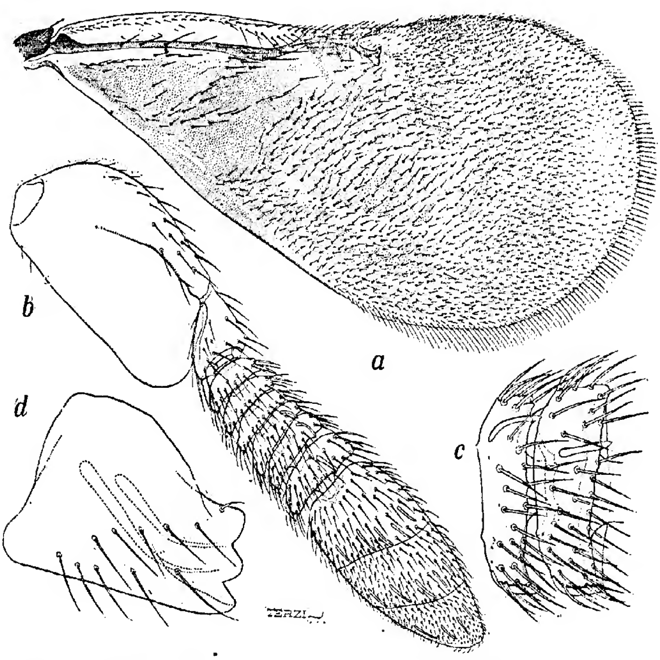

Fig. 3. *Eusemion cornigerum*, Wlk., ♀; (*a*) fore wing, (*b*) antenna, (*c*) fifth and sixth funicular joints, (*d*) right mandible.

edge. On each side of these pustules the apical one-third of the scutellum is smoother with, under a moderate power (up to ×80), a number of minute black dots surrounded by a more shiny area; when rendered transparent, mounted in balsam, and highly magnified these dots appear to be the external openings of tube-like sensory (?) structures (30–40 in all). Each structure lies at the angle of a cell in the reticulation and stretches forward anteriorly through the chitin. No sensory bristles are however visible, even with a magnification of over 600. Besides the bristles already noted, there are two longer, stouter ones apically in the middle (1, 1).

Metanotum in two triangular portions each of which shows anteromedianly 3–4 very short longitudinal rugae and about the same number transversely

situated. Propodeon with 3 short descending median rugae flanked on each side by one or two incomplete cells; 3–4 rugae before the spiracle, which is nearly circular and of moderate size. Metapleurae with 9–10 bristles.

Wings. Fore wings (fig. 3, *a*) 2½ times as long as broad, length 1·07 mm., breadth ·43 mm. Submarginal : marginal : radius : postmarginal, as 40 : 10 : 5 : 3⅓; *i.e.*, the marginal is relatively longer than in *E. pattersoni.* Compared with that species also there are 1–2 fewer bristles on the submarginal vein and all the major bristles on the neuration are a little shorter; 2 bristles on the radius, 1 near base and 1 sub-apical; 6–8 long bristles inferiorly at the apex of the submarginal cell. The conspicuous differences in the chaetotaxy of the wing-bases of *cornigerum*, *italicum* (fig. 4) and *pattersoni* are figured. Hind wings, length ·78 mm., breadth ·19 mm.; 11 bristles on apical half of the neuration. Both wings, especially the posterior pair, are distinctly narrower than in *pattersoni.*

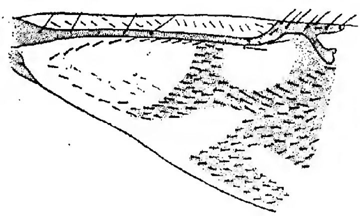

Fig. 4. *Eusemion italicum*, Masi, ♀; basal half of fore wing.

Legs. Fore legs with the femur (4 : 1) broader than in *pattersoni.* Femur of mid legs a little over 5 : 1; the tibia not quite 5½ times as long as broad; apparently fewer heavy spines on the first tarsal joint. Hind tibial comb as in *pattersoni.* The first and second tarsal joints of the mid and hind legs are in ratio 3 : 2, the first joint being relatively shorter than in *pattersoni.*

Abdomen (9 : 8) with the sheath projecting between one-seventh and one-eighth of the length of the abdomen. Dorsal surface medianly smooth, faintly reticulate laterally and narrowly towards the middle behind the setigerous process. On the first tergite are two narrow transverse widely separated belts (each occupying about one-third of the total breadth) of small much raised cells with thickened walls, which produce a slight refringence.

Length, about 1 mm.; alar expanse, 1½–2 mm.

BRITAIN: Surrey, Camberley, bred from the Coccid *Parafairmairia gracilis*, viii. 1915, 4 ♀♀ (*E. E. Green*).

There are apparently no Walkerian examples of this species in the British Museum, and I am not aware of any recent records of *E. cornigerum.* Haliday's figures (Entom., 1841, pl. H., figs. 2, 2, *a*), though on too small a scale to convey much information, are fairly satisfactory. Walker records the species from the Isle of Wight and Fontainbleau. Mayr (Verh. zool.-bot. Ges. Wien, xxxv, 1876, p. 749) records *cornigerum* from Coccids on *Prunus* and states that Kreichbaumer reared a female from a Coccid on grass. *Parafairmairia* is also a grass Coccid.

In a recent letter my friend, Dr. L. Masi, suggests the name *italicum*,* Masi, for the species which I have already discussed (Bull. Ent. Res., 1916, p. 249). *C. latevittatus*, A. Costa (1882), has probably nothing to do with *italicum*. Dr. Masi has recently ascertained that Costa's type is lost.

The following key to the females of *Eusemion* may be given:—

Mandibles tridentate; club of antenna distinct, funicular joints gradually expanded, the sixth widest . . . . *cornigerum*, Wlk.

Mandibles bidentate (the two upper teeth being fused into a broad cutting edge); club and funicle band-like, the former indistinctly separated, only the first normal funicular joint a little narrower, 2-6 equal in width.

Scape subquadrate, large, its greatest length (from head of the bulla to the antero-ventral angle) just equal to the funicle measured along the dorsal edge . . . . *italicum*, Masi.

Scape subtriangular (its dorsal edge convex), smaller, only as long as the first four funicular joints . . . . . . *pattersoni*, Waterst.

Genus Habrolepis, Först.

Habrolepis, Förster, Hym. Stud., ii, 1856, p. 34.

Four species of this remarkable genus have been described, and only one as yet from Africa (*H. oppugnati*, Silv., Boll. Lab. Portici, 1915, p. 299, figs. lv and lvi). From *H. oppugnati* the present species differs conspicuously in the antennae, especially in the funicle. Professor Silvestri's species was reared from *Aspidiotus oppugnatus*, Silv., found at Nefasit, in Eritrea.

Habrolepis apicalis, sp. nov.

♂. Blackish brown, the head and thorax a little darker than the abdomen, the under surface of which is slightly lighter than the upper. Wings hyaline; veins of forewings yellowish, with only a faint and limited clouding about the marginal. Trophi anteriorly pale; cardo, stipes and mentum smoky. Antennae with the bulla and scape whitish, the rest yellow, tinted; pedicel (especially superiorly) and funicle faintly embrowned; apical fourth of the club with a distinct brown spot. Fore legs pale yellow; the tibia narrowly and indefinitely near the base along the dorsal edge and the tarsi a little embrowned. Mid legs purer yellow, with brown coxae, and faintly banded with the same colour for one-fourth the length, beginning at one-fifth from the base. Hind legs mainly brown; the trochanters, bases of femur and tibia (narrowly) and apex of tibia (broadly) paler. Tarsi hardly so dark as the femur.

Head, from in front, broader than long (11 : 9); eyes rather small, wide apart, separated at the anterior ocellus by about one-half and on the base line by six-sevenths of the width of the head. Toruli mid-way between the anterior ocellus and the clypeal edge and well above the base line of the eyes, large, oval, equidistant superiorly from one another and the orbits. Clypeal edge concave. Pattern of face distinctly raised, coarse, everywhere transverse. Five pairs of bristles between and below the toruli and another pair on the clypeus well above the edge; on

* See Masi, Ent. Mo. Mag. (3) iii, April 1917, p. 80.

each side of the clypeus up to the genal keel 9–11 bristles, 3 being before the keel, 5–6 along each orbit up to the level of the toruli. The eyes bear scattered very minute bristles. Vertex and upper frons very strongly raised reticulate so as to appear rough-pitted; lateral ocelli just over one-half their diameter from the orbits.

Mouth-parts. Labrum narrow, two-fifths the width of the clypeal edge, with a rather stout bristle at each lateral angle and two clear pustules medianly above the edge. Mandibles (fig. 5 *b*, *c*). Maxillary palpus, 10 : 7 : 9 : 17 (measured along the outside edge); first joint triangular, constricted basally, bare, as also is the second; the third with two bristles; fourth joint (as wide as the length of the second) with about a dozen bristles evenly distributed and 3 much longer (hyaline) at or near the apex. The galea bears 8–9 shorter superficial bristles and 6–7 more spine-like ones on or near the edge. Labial palpus, 8 : 2 : 7; the second joint hardly discernible on the inner edge.

Antennae (fig. 5, *a*). Length ·55 mm., bulla (6 : 5) two-fifths of the scape, which is, as in *H. dalmani*, Westw. (Philos. Mag., x, 1837, p. 440), nearly twice as long as broad. Pedicel about as long as the scape is broad, hardly longer than broad (17 : 15) and shorter (17 : 20) than, but as broad as, the first normal funicular

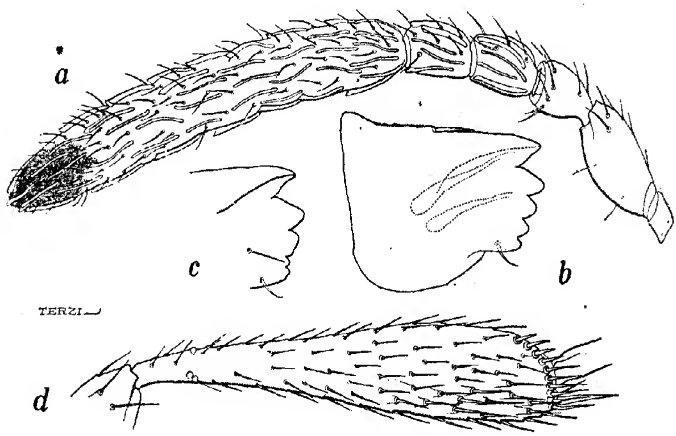

Fig. 5. *Habrolepis apicalis*, sp. n., ♂; (*a*) antenna, (*b*) and (*c*) mandibles, (*d*) hind femur, posterior aspect.

joint, which in turn is shorter than the second (20 : 23); ring joint minute. The two funicular joints (as long as bulla and scape together) are, with the club, in the ratio 5 : 6 : 35. Taking the width of the funicle as 3, that of the club at its maximum is about 4. The sensoria of the funicle and club are long and numerous; the bristles are sparsely set (fig. 5, *a*).

Thorax just longer (9 : 8) and wider (10 : 9) than the abdomen, which is as broad as the head. Pronotum with the spiracular emargination small, shallow and indistinct, with 1 strong and 1 weaker bristle above the posterior row (6, 6), and

8–10 shorter ones in front and 4–5 minute scattered bristles towards the mid-line; overlaps bare, the reticulation very large and drawn out; mesoscutum broader than long (9 : 7) and longer than the scutellum (7 : 6), with about 30 stiff bristles on each side of the mid-line; axillae with 2–3 bristles; scutellum with 10 bristles in two curved lines (3, 2) about the mid-line. The sensory pustules far back at three-fourths from the suture; the hindmost pair of bristles stronger and longer. About one-sixth of the scutellum overhangs the metanotum. The propodeon consists of two narrowly connected quadrate areas; spiracle oval, one exterior bristle; metapleurae bare. The entire notal pattern boldly raised; on the mesoscutum the reticulation is large and regular, a little smaller, but more pitted on the mid-scutellum, but more scaly towards the sides; on the axillae scaly, tending to rugulose; metanotum and propodeon transversely rugulose, only a small spot inside each spiracle smoother. Mesosternum finely transverse-reticulate, little raised, mesopleurae mainly finely striate-reticulate, but the pattern anteriorly and again near the posterior edge larger and more regularly reticulate. Tegulae and prepectus both rather large, with the large boldly raised pattern in the latter divided into equal triangular areas by the internal incrassation.

Wings. Forewings, length ·68 mm., breadth ·28 mm. (excluding fringe). Similar to those of *H. oppugnati*, Silv., but differing as follows: in the forewing (cf. l.c. fig. lvi, 2) the terminal ventral bristle of the postmarginal shorter and finer than the 6 fringing the marginal and postmarginal above. Only 5 sloped transverse rows of discal ciliation below the uprise of the marginal vein. Hindwings, length ·4 mm., breadth ·09 mm.

Legs remarkable for the great development of the middle pair, which when fully extended are nearly as long as the entire insect, half as long again as the fore legs or about one-fourth longer than the hind legs. Fore legs: coxae (4 : 3) with about a dozen external bristles, some heavier, ventrally, and on inner surface a distinct patch (5–6) of minute bristles medianly; femur 4 : 1, tibia rather broad (10 : 3), the spines of the apical comb (5) long and thin; comb of first tarsal joint (5 spines) confined to apical half. Mid legs: coxae elongate, with about 16 external bristles, the reticulation of longish, distinctly raised cells; femur (23 : 3) just shorter than the tibia (at base 10 : 1, at apex 6 : 1), with 4 short peg-like spines anteriorly at apex, the upper angle of which is heavily chitinised; spur $\frac{7}{8}$ of the first tarsal joint, which bears antero-ventrally 7 very stout spines, of which joints 2–4 bear 2, 1, 1 respectively. Hind legs: coxae broad (8 : 7), with 3 stronger external bristles above the trochanter and about 20 in front; tibia extremely narrow (17 : 1) at the base and then expanded like a club to about 5 : 1 at one-fourth from the apex; the apical comb extends backwards shortly and contains 10 spines.

Abdomen. Medianly smooth, the tergal overlap striate. Tergites 1–6 medianly subequal in length; 1–4 with straight hind margins; 5 and 6 posteriorly convex; 7 half longer than the others, straight-edged; 1–6 bear at each side 3–4 bristles, forming a complete row on the sixth, widely separate on 1–4; the seventh bears about 15 bristles (3 rows). Spiracle minute, circular; the spiracular pleurite nearly separate from the tergal portion, with 7–8 bristles posteriorly. The overlaps of tergites 2–5 show 1–2 pustules, which may be setigerous, but if so, in neither specimen have the bristles persisted. The process on tergite 7 distinct,

broad, with 5 bristles, 2 outer short, the innermost moderate, and the central pair long, exceeding the tip of the abdomen and reaching to about the level of the penis hooks when the genitalia are exserted. The lateral hooks of the penis single, short and thick.

Length, ·7–·75 mm.; alar expanse, 1·45 mm.–1·55 mm.

GOLD COAST: Aburi, ex *Chionaspis minor*, 19. v. 16, 2 ♂♂ (*W. H. Patterson*).

Type. ♂ in the British Museum.

Genus ASPIDIOTIPHAGUS, Howard.

Aspidiotiphagus, Howard, Insect Life, vi, 1894, p. 230.

Aspidiotiphagus citrinus, Craw, Destructive Insects, Sacramento, Cal., 1891, p. 28, fig.

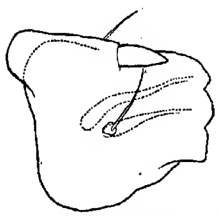

Fig. 6. *Aspidiotiphagus citrinus*, Craw, ♀; mandible.

The following examples of this species have been received by the Imperial Bureau:—

CEYLON: Peradeniya, ex *Chionaspis graminis*, 24.vi.13, 2 ♀♀ (*A. Rutherford*).

RHODESIA: Salisbury, ex *Aspidiotus camelliae*, 16.ix.09, 5 ♀♀ (*R. W. Jack*).

GOLD COAST: Aburi, ex *Chionaspis minor*, 19.1 16, 2 ♂♂, 7 ♀♀ (*W. H. Patterson*).

The above specimens agree very completely amongst themselves and with a single female in the British Museum (determined by Dr. L. O. Howard) from Grenada (Howard, Linn. Soc. Lond., Zool., xxvi, 1896, p. 156).

Family MISCOGASTERIDAE.

Although the genus described below has been known to me for some time, I had not ventured to regard it as new till lately, when Mr. A. A. Girault returned an example of the genotype as unknown to him. The systematic position of *Eriaporus* is a little uncertain. It is formally a Miscogasterid and Mr. Girault would go further and assign it a place in the PIRENINAE. But the three-jointed maxillary palpus and the deeply advanced axillae are anomalous for the subfamily, so far as I know it.

Genus ERIAPORUS, nov.

♀. *Head*, from in front, broad, contracted towards the mouth-edge. Clypeal edge straight medianly, horizontal; sides straight, sloping towards the genal keel. Toruli quadrangular, superiorly trunctated, placed just clear of the base line of the eyes; post-scapal hollows deep, inclined at an acute angle towards one another and meeting in front of the anterior ocellus. The area actually

between the toruli flat and raised, but coming to an acute pointed ridge superiorly, where the scapal grooves coalesce. Frons and vertex broad; occiput and vertex meeting in a distinct edge, which is not however chitinised, ridged or internally thickened. Eyes moderate, a little prominent, bare. Vertex and frons with a few remarkable stout curved spine-like bristles in addition to others of a more usual calibre.

Antenna 9 (11)-jointed: scape, pedicel, 2 ring-joints, 4 in funicle, club with 3 segments, the distal suture indistinct.

Mouth-parts. Labrum oblong, straight-edged, mandibles bidentate, the upper tooth with broad edge. Maxillary and labial palpi both 3-jointed.

Thorax. Pronotum broad, not deeply emarginate antero-medianly; spiracular emargination very small; postero-lateral angles extending considerably beyond the hind marginal row of bristles. Prosternum pentagonal, the postero-lateral edges practically in one line, with distinctive apophysis. Mesonotum with the parapsidal furrows straight, distinct and deep; mid-lobe with numerous stout bristles; parapsides with a longitudinal row of 5 spinose bristles and 3 even stouter before the tegula, deeply invaded by the axillae, which bear several spinose or weaker bristles. Scutellum with 6 bristles (3, 3); the 2 sensory pustules minute and posterior; mesophragma very short, apically bilobed. Prepectus quadrate, with a narrow median connection; pleurae distinctly impressed; a strong internal chitinisation from the antero-ventral angle of the episternite to the insertion of the mid-coxae. Epimeron separated off by an incrassation, except just above the coxae. Metanotum and propodeon broad, narrow, medianly carinate.

Wings. Forewings with the junction of marginal and submarginal thickened; marginal long; postmarginal and radius well developed, subequal; submarginal with long stout bristles; submarginal cell rather deep. Basal area of wing bare. Hindwings with the hind margin very concave near base.

Legs. Fore legs with one stout long spinose black femoral bristle, subapical and ventral; first tarsal comb not transverse, lateral but occupying the mid half of the ventral edge. Mid legs with 2 heavy subapical spinose femoral bristles and a rather weak long frayed tibial spur. Hind legs with the coxae large and broad; femora with a distinct antero-ventral groove on apical two-thirds, receiving the folded tibia, the edge posteriorly flattened; tibia bicalcarate. In all the tarsi the first joint is long, and the fifth somewhat expanded.

Abdomen. Segments sub-equal, the first shorter than 2–4. Free portion of the sheath short in proportion to the base.

Eriaporus laticeps, sp. nov.

♀. Vertex and frons pale yellowish; antennae pale with a reddish brown tinge on the scape, the funicle more or less infuscated, especially on the club; ocelli chestnut brown, eyes darker, occiput blackish brown, genae yellowish brown, mandibles pale, brown-tipped. Thorax and abdomen blackish brown, but the tegulae distinctly pale and the anterior edge of the pronotal collar narrowly lighter. On the first visible abdominal segment are two large yellow spots, separated medianly by rather less than their own breadth of the ground-colour,

each spot containing antero-laterally a much smaller paler indefinite brown mark. The wings are hyaline, clouded narrowly at the junction of the submarginal and marginal veins; neuration very pale brown. Fore coxae pale, hind coxae concolorous with thorax, mid coxae pale, slightly darker externally; otherwise the legs are very pale, only the claws embrowned.

Head, from in front, very broad (4 : 3), mouth-opening moderately narrow; the space between the extremities of the genal keel four-fifths the shortest distance across the frons. Eyes moderate, occupying three-fifths of the depth. Frons broad, the orbits continuously rounded, at their nearest over one-third (6 : 15) of the entire width of the head, the distance increasing on the base line to about three-fifths; frons ventro-laterally well developed, the genal keel far back, with the lower rounded angle of the eye in front. Toruli (8 : 5) with the inner sides subparallel, $2\frac{1}{4}$ times their own length from the clypeal edge, a little more than their own length (9 : 8) apart; and about $1\frac{1}{2}$ times their length from the orbits. Reticulation rather large, distinct and regular, especially superiorly, flowing round the toruli ventrally, where it becomes faint. In each upper frontal angle are 4 stout coloured spinose bristles, 2 standing on the upper orbit. There are no well-differentiated orbital bristles, but 7–8 minute and weaker ones stand in the place of the usual row, with about as many more towards the outside of the scapal groove; similar weak bristles (4–5 pairs) between the toruli. About the mid line on each side below the toruli, the lower frons bears 8–10 weak minute bristles, and there are 4 (2, 2) well above the clypeal edge, the middle pair stronger. In profile the head is antero-posteriorly thin, the genae proper flattened; from above the head is lenticular, markedly concave posteriorly, the occipital edge decided. Ocelli in a broad triangle, the posterior pair on the occipital edge, with two stout bristles between. On each orbit vertically are two more stout bristles in addition to those already mentioned.

Antennae. Length ·75 mm. Bulla short, transverse, narrower than scape basally. Scape (6 : 5) tapered neither at base nor apex, longer than the club, and as long as the pedicel, ring joints, first and one-third of the second funicular joints. Pedicel (5 : 3) half as long as the scape. Ring joints distinct, the edge of the second (distal) covered on the inner aspect by a flange of the first; funicle cylindrical, joints subequal, the first and second just longer than wide, third and fourth just transverse; the club (5 : 5 : 3) wider (7 : 6) than the last joint of the funicle and exceeding the length of the last two funicular joints together. The scape externally with a coarse pattern, with 7–8 oblique transverse rows of bristles (2–4 per row) and densely clothed on the inside with minute stiff bristles along the dorsal half to two-thirds ventrally and subventrally bare; on the inner aspect at the apex 2 stout spinose bristles; pedicel with several scattered bristles, 1 stouter and spinose externally before the upper apical angle; both ring joints with a marginal row of stiff spinose bristles; on the funicle the bristles are mainly spinose and curved, with numerous small "mushroom" bristles, presutural in position. The sensoria low and not produced apically, 6–8 on funicle joints, and about a dozen on the first club segment.

Mouth-parts. Labrum with four bristles; stipes with a bold pattern and 3 bristles; maxillary palpus (8 : 5 : 7), the first joint with 1 bristle beyond one-half and 1 clear

pustule apically; second joint with 5 bristles and a pustule; third with 8–9, one at apex longer than the joint. Mentum with 5–6 bristles about the mid-line. Labial palpus (10 : 6 : 9), the middle joint simple, transverse, as wide on the inner edge as on the outer; two setigerous cells on the ligula, the setae flat and broad. Mandibles moderately long, considerably contracted distally; at base (7 : 5), at apex (7 : 3), ventral edge straight.

Thorax. Pronotum with 1 strong spiracular bristle, about 10 (5, 5) on hind margin; between the spiracular bristle and the last of the posterior row 3 weaker bristles; in front of the posterior row about 15 minute ones in a row; anteriorly on each side of the mid line about 14 bristles mainly in two patches far apart, though one or two stand near the middle. Mesonotum (12 : 11) very broad; mid lobe much broader than long (4 : 3), and just equal to the scutellum in length, with

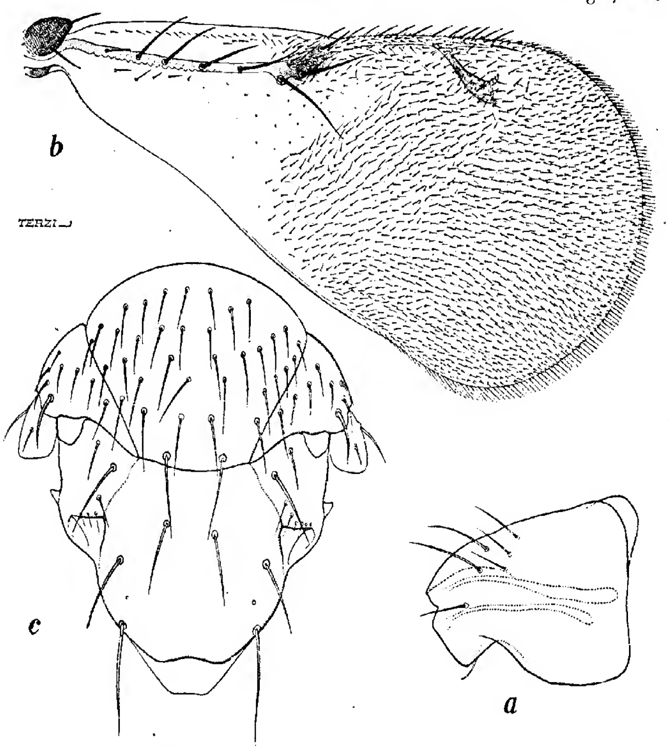

Fig. 7. *Eriaporus laticeps*, sp. n., ♀; (*a*) mandible, (*b*) right fore wing, (*c*) mesonotum (a little flattened to show complete chaetotaxy).

about 35 stiff bristles, of which 2 placed almost on the suture dividing the base of the lobe in ratio 5 : 7 : 5 are stronger. Axillae large, with one longer bristle at inner angle, another shorter well in advance, and 4–6 much shorter along the hind margin. Scutellum with 2 (1, 1) stout bristles overhanging the propodeon, another similar

pair in front, and a third pair inwardly displaced at one-third from the suture. The clear sensory pustules are minute, one on each side between but a little inside the lateral bristles. The projecting part of the mesophragma is only about one-seventh of the scutellum in length. Sternopleurae ventrally flattened and expanded antero-laterally, the divide between the pleural and ventral areas of the sternum proper occurring along the thick ridge extending from the mid coxa to below the episternite. The distance between the anterior extremities of these ridges, when the sternopleurae are flattened out, is about twice (17 : 9) that between the hind ends. Between the anterior end of the ventral ridge and the episternite one moderately long weak bristle; one at each postero-lateral angle of the sternum, and a median pair both anteriorly and posteriorly at the edge about the mid line, the former rather widely separated. In the middle the post-scutellum is overhung for the greater part by the scutellum, the concealed part being pentagonal in shape, with a broad median thickening in line with the propodeal keel; the exposed part consists of two narrow descending rugulose areas touching medianly. The sunken side areas are bounded laterally by distinct ridges, besides being incompletely divided by ridges rising from the lateral ends of the rugulose areas but fading out half-way towards the sides. Propodeon broadly smooth medianly, except for one or two raised cells in the antero-median angles. The keel (highly magnified) consists of two closely applied ridges. From half-way between the median keel and the spiracle the surface shews a strongly raised, coarse, rather thick-walled reticulation, which extends on to the metapleurae. There are no pre-spiracular lateral keels, but posteriorly (from one-half to the hind margin) there is a short thickened fold in the chitin. Spiracle moderately large, oblong oval, lying on the edge of a distinct elongate sulcus; 12–15 bristles outside the spiracle. The propodeon is laterally ridged and expanded, with the postero-lateral angles right angles, and the sides a little convexly convergent.

Thoracic sculpture. Pronotum with the reticulation decided and raised, cells of moderate size, quadrate or pentagonal, mainly oblong-transverse, the largest and most feebly marked antero-ventral. Prosternum with the somewhat large cells radiating antero-laterally from the mid line. Mesonotal pattern finer, nearly everywhere regular (coarser anteriorly on the mid lobe and laterally on the scutellum); all the cells with slightly thickened raised walls, hexagonal. On the sternopleurae the pattern is rather faint, except on the postero-median half of the mesepimera, where there are a number of coarse raised cells in an irregular patch, with one or two striae above and some incomplete cells towards the mid-coxae; otherwise the epimeron is smooth, *i.e.*, the femoral impression is posteriorly gleaming. Below the forewing the upper portion of the episternite is weakly, finely striate, nearly smooth. The rest of the sternopleurae shew a regular moderate reticulation, more pronounced on the sides of the thorax, with a small smooth spot (behind one-half) on the rounded edge immediately below the incrassation from the mid coxae. The prepectus has a coarse delicately impressed reticulation.

Wings. Forewings (fig. 7, *b*) very broad, the length only a little over twice the breadth; length 1·25 mm., breadth ·57 mm. Hindwings about 3⅔ times as long as broad, length ·98 mm., breadth ·27 mm., deeply concave on basal one-third of

hind margin; with 18–20 longish bristles on the narrow submarginal cell, 5 short bristles at the hooks; discal ciliation short, regular, only the base narrowly bare.

Legs. Fore legs with the coxae (20 : 11) large, five-sixths of the femur in length, pattern coarse, transverse and scaly on the outside, with 3 long bristles ventrally and about a dozen above; femur (8 : 3) covered with minute bristles on the posterior aspect, on dorsal two-thirds 2–8 deep and ventral bristles, 3–4 deep, longer and more widely spaced; anteriorly 1–2 subventral rows of minute bristles, with many more on apical two-thirds from dorsal edge to below half; tibia (4 : 1) with the apical comb interrupted, 2 spines at base of spur, 3 heavier ones above the base of the tarsus, and 1 pre-apical median spine; comb of first tarsal joint with 8–9 spines. Mid legs: anteriorly on the collar-like edge and perpendicularly above the trochanter, the coxa bears 8–9 bristles, 3–4 being stout, as well as a patch of (60–70 minute ones); femur (13 : 4) with 2–8 short bristles antero-subventrally up to three-quarters from the base, otherwise bare, except for numerous minute close-set subdorsal bristles mainly on the apical half; tibial spur thin, a little over three-quarters the first tarsal joint, which bears laterally 6–7 short sharp hyaline (not peg-like) spines; second to fourth tarsal joints bearing 4, 2, and 1 respectively. Hind legs with the coxa (5 : 3) very large, only a little shorter than the femur (7 : 8), very coarsely raised-reticulate on the outer posterior aspect; femur (3 : 1) with a subventral row of about 10 bristles, those on the apical half being longer; between these longer bristles and the dorsal edge are about 20 bristles on the apical third; posteriorly above the tibial impression are 5–6 bristles, while the apical third, as on the anterior surface, bears several minute bristles; tibia moderately flattened (6 : 1), densely clothed with bristles, along the dorsal edge 30 or upwards stouter and hyaline, increasing in length apically, form a conspicuous closely appressed row; at the upper anterior apical angle stand 2 short stout spines, and 2 others not so strong below the middle just clear of the two spurs; the posterior comb consists of 12–13 spines; the first tarsal joint bears ventrally up to 10 clear sharp spines, there being 3 on the second joint, and 1 on the third, besides other finer bristles. In all the tarsi, joints 3–5 are approximately in the ratio 18 : 15 : 21, the fifth being a little longer in the hind tarsus. In the fore legs 1 and 2 are in the same scale 36 : 24, in the mid legs 66 : 30, and in the hind pair 50 : 30.

Abdomen broad (5 : 4), about one-fifth wider than the thorax and one-quarter longer, the sides very convex (tergites 2–4 when flattened out much the broadest), posteriorly shortly pointed. Tergite 1 much the longest (8), 2–5 subequal (about 5), 6 shorter (the exposed part only 2½). In tergite 1 the posterior margin is medianly gently convex, in 2–4 nearly straight, in 6 medianly convex, with a shallow concavity at each side before the spiracle. In the ovipositor the free portion of the sheath (less than one-third of the base) bears 5 bristles proximally and 10 on the pointed apical half; the base bears a row of 7–8 bristles. In the actual ovipositor only the apical one-tenth is serrate, bearing 3–4 rather large subapical teeth.

Length, about 1½ mm.; alar expanse, 3 mm.

Gold Coast: Aburi, "on cocoa Coccid," 4.i.13, 4 ♀♀ (*W. H. Patterson*).

Type ♀ in the British Museum.

SOME FLY POISONS FOR OUTDOOR AND HOSPITAL USE.

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The method of poisoning flies by the exposure of solutions of sodium arsenite and sugar is one that has been advocated by entomologists in Italy and in South Africa for some years, and yielded good results in Mesopotamia in 1916; for in hot climates, where flies come readily to sugar solutions, the use of an outdoor poison is specially valuable. But there are obvious disadvantages in using any arsenic solutions; for not only are they poisonous in themselves, but the disposal of residues is not easy, as the arsenic and sugar remain poisonous if thrown away, or if they dry on sand or soil. It would thus be useful to substitute for arsenic some compound less poisonous to man and less stable in a soluble form when thrown away.

The only generally known poison besides arsenic is formaldedyde, which is excessively variable in action and too volatile for outdoor use in a hot climate. There are many formulae for its use indoors, varying usually from about 1 to 4 per cent. of the formaldehyde. Phelps has recently suggested sodium salicylate (U.S. Public Health Reports, Washington, D.C., xxxi, 1916, pp. 3033–3055) as an indoor poison, and this seems suitable for outdoor use also. There have been other suggestions, such as quassia, bichromate, pepper, etc.; and Morrill has tested and reported on a number of other substances (Jl. Econ. Entom., vii, 1914, p. 268). This matter was tested by Miss Lodge on *Musca domestica* in 1915, and details of her experiments were published (Proc. Zool. Soc. London, 1916, pp. 481–518). She tried a considerable range of compounds and found potassium iodate a hopeful substance. In 1916 Miss Lodge did further work, particularly with sodium iodate and formaldehyde. With the former she killed from 90 to 99 per cent. of flies in the morning after offering the poison, *i.e.*, within 18 hours, and the flies fed on the bait readily. She tried other sodium and potassium compounds, but no very definite decision was reached. An account of these experiments will be published shortly, with her other work, and Miss Lodge has kindly allowed us to quote her results.

In 1917, having the experience in Mesopotamia with sodium arsenite as a basis, the writers made further trials with fly poisons. The substances were tested (with 20 per cent. sugar solutions) usually at a strength of 2 per cent. by weight; they were offered to flies in confinement in large glass cylinders with gauze covers, and anything abnormal was noted. The results obtained are by no means decisive; but as they may be useful to others who may be engaged in testing possible poisons, we have decided to record them. It is convenient to class the compounds in three divisions:—

(1) Those that kill quickly;
(2) Those that kill on the second day; and
(3) Those that seem to be harmless at the strength tested (2 per cent.).

As our object was to find as quickly as possible a poison to replace arsenic, which is used at 2 per cent., we used our substances at that strength, and we went no further if the flies fed freely and did not suffer. If there were signs of poisoning, the substance would be tried up to 5 per cent. and down to ·02 per cent., if necessary. The results obtained with substances found to be poisonous are summarised below; where no strengths are given a 2 per cent. mixture was used.

To help others and to obviate testing ineffective substances, we attach below a complete classified list of all the substances tested in 1915–1916 by Miss Lodge, and in 1917 by ourselves, with the results.

Methods.

The experiments were carried out in the Fly Room at the Imperial College of Science, which had been set apart for the breeding and keeping of flies (*Musca domestica*), so that a continuous supply of the insects for experimental purposes was insured. A weighed amount of the chemical to be tried as a poison was added to a measured quantity of standard 20 per cent. sugar solution; if the chemical was insoluble, it was made into as fine powder as possible and mixed up with a known quantity of food mixture. The food mixture used was approximately 2 parts casein, 2 parts banana and 1 part molasses, mixed with water to form a paste. The solution or food mixture was then placed under a glass cylinder with a muslin top; if a solution, a piece of filter paper was placed in the dish to enable the flies to feed more easily and prevent them from being drowned. The requisite number of flies was then caught by means of a wire balloon-trap and released in the cylinder, the hour at which they were released being noted. In some cases the flies fed very soon, in others it was an hour or two before many flies were observed feeding. This depended on (1) whether the flies were hungry or not, (2) whether the chemicals employed were liked or disliked by them. The dead flies were counted about 5 p.m. on the day the experiment was started (if the experiment had been started early that morning, a count was also, in some cases, made at noon), and at 10 a.m. next day. If no flies, or only a few, were found dead at this last count, the chemical was considered to have failed and was placed in Class III. If about half the flies were dead, the chemical was regarded as moderately good and placed in Class II. If all or most of the flies were dead, then the chemical was classed as good, placed in Class I, and further experiments with it, at different strengths, were carried out in order to discover the lowest strength which killed flies effectively; also the point at which the chemical ceased to be harmful to flies.

Some of the chemicals tried were more or less distasteful to flies. Thus, ammonium 3:5 ortho-dinitro-cresylate, in strengths of from 2 per cent. down to ·05 per cent. in sugar solution placed out on the bench, was not liked by flies; though they came readily to ·025 per cent. in sugar solution, which however had no poisoning effect on them. To ammonium fluoride and ammonium iodate at the same strengths they came readily, the 2 per cent. strengths being quite as much liked as the lower strengths.

The following are the substances placed in Classes I and II which have some killing power:—

CLASS I.

Sodium arsenite (2% and 1%) kills flies effectively.

Antimony arsenate is very insoluble; a weak solution was fed to flies, and next morning all were dead. As this chemical is a powerful human poison, no further experiments were carried out with it.

Sodium fluoride (5%, 2% and 1%) kills flies effectively; at 5% and 2%, 80% were killed. The 5% solution was a saturated one, as all the sodium fluoride would not dissolve. This substance is not deterrent to flies, and its addition to sugar solution does not make the latter distasteful to them.

Sodium bifluoride (2% and 1%) is an effective fly poison, but is less soluble than sodium fluoride and the 2% solution is a saturated one.

Potassium fluoride (2%) kills flies effectively, but is less soluble than the sodium salt.

Ammonium bifluoride (2% and 1%) kills flies effectively, but is less stable than ammonium fluoride: at 5% strength, 80% flies were killed.

Ammonium fluoride (2%, 1%, ·5% and ·2%) is a good fly poison: at 5% strengths it is less effective, only 66% being killed. It is more soluble than the sodium and potassium salts, but at high temperatures is said to be less stable, decomposing and giving off hydrofluoric acid. However, as these poisons are primarily intended for outdoor use, this instability, provided it did not occur at once on exposure, would be of little account; in fact, as all these fluorides are more or less poisonous, though to a far less extent than the arsenic compounds, its property of decomposing would be an added advantage, as it would obviate any danger from the substance when lying about after use. Sodium arsenite, on the other hand, always remains poisonous. The advantages of the ammonium and sodium fluorides as compared with sodium arsenite are that, while being apparently as effective fly poisons, they are far less poisonous to man. They are also cheap and readily obtainable. A comparison between the killing powers of 2% and 1% strengths of sodium arsenite and sodium and ammonium fluorides gave the following results:—

	Fed to flies.	No. of flies.	No. dead at 5 p.m. same day.	No. dead at 10 a.m. next day.
2% Sodium arsenite..	2.30 p.m.	76	16	66
2% Sodium fluoride ..	3 p.m.	18	12	16
2% Ammonium fluoride	12.20 p.m.	29	20	28
1% Sodium arsenite ..	2.30 p.m.	39	8	36
1% Sodium fluoride ..	4 p.m.	23	10	22
1% Ammonium fluoride	3 p.m.	43	21	42

Sodium and *potassium iodates* were tried by Miss Lodge and gave satisfactory results, which we confirmed. In addition we tried ammonium iodate at 2%, 1%

and ·5%, which also proved an effective fly poison. The iodates however are less soluble than the fluorides and much more expensive. We obtained the following figures:—

	Fed to flies.	No. of flies.	No. dead at 5 p.m. same day.	No. dead at 10 a.m. next day.
2% Sodium iodate ..	11.30 a.m.	42	34	41
2% Potassium iodate	11.55 a.m.	27	5 (2. 20 p.m.)	27
2% Ammonium iodate	1 p.m.	86	46	86
1% Sodium iodate ..	12.30	37	1	32
1% Potassium iodate	1 p.m.	49	1	44
1% Ammonium iodate	1 p.m.	54	33	53

Ammonium and *potassium* 3 : 5 *ortho-dinitro-cresylate* (5%, 2% and 1%) gave encouraging results, but a further series of experiments proved that these substances, at the above strengths, render the food or solution distasteful to flies, which only feed upon it when forced to do so by hunger. This was borne out by the few deaths recorded at the first count; while at the second count most or all of the flies had succumbed.

Ammonium 3 : 5 *para-dinitro-cresylate* did not give such good results as the ortho-dinitro-cresylate.

Sodium and *potassium salicylates* (2% and 1%) will poison flies, but they appear to act more slowly and fail to kill at weaker strengths, such as ·5%, and therefore are only to be recommended when fluorides and iodates are unobtainable. They gave the following figures:—

	Fed to flies.	No. of Flies.	No. dead at 5 p.m. same day.	No. dead at 10 a.m. next day.
2% Sodium salicylate	2.15 p.m.	148	9	98
2% Potass'm salicylate	2.30 p.m.	27	3	25
1% Sodium salicylate	2.15 p.m.	123	2	83
1% Potass'm salicylate	12 a.m.	29	8	17

Class II.

Magnesium per-borate, approximately at 2% strength (the substance was rather insoluble), killed 36 out of 66 flies at the second count (10 a.m. next morning).

Copper sulphate (5%) killed 50% of the flies by 10 a.m. the next morning.

Cuprol (2%) in food mixture accounted for 65% on the morning of the third day.

Cadmium sulphate (5%) poisoned 8 flies out of 66 by 5 p.m. of the first day (experiment started 10 a.m.), and at 10 a.m. next morning 46 in all were dead; a 2% strength poisoned 1 out of 16 on the evening of the first day, and by next

morning all were dead; a 1% solution killed 18 out of 58 on the morning of the second day. As cadmium salts were considered too poisonous for practical use, further trials were abandoned.

Paris green. This insoluble arsenic salt was thoroughly mixed with food mixture at a 2% strength and was fed to flies; at 10 a.m. next morning, 6 flies out of 16 were dead and by 5 p.m. 12 out of 16. As this substance is excessively poisonous no further trials were made.

Cacodylic acid (1 : 1,000) accounted for 38 out of 53 flies by the morning of the second day. As it is excessively poisonous, no further experiments were made.

Toluol parachlorsulphonate was very insoluble; to get it into solution alcohol had to be added. An approximately 2% strength killed no flies the first day and about 50% by the morning of the second day.

Phenyl hydrazine hydrochloride (2%) killed 3 out of 35 by the evening of the first day, and 23 out of 35 by 10 a.m. next morning.

Pyrogallic acid (2%) killed no flies on the first day; on the morning of the second day 16 out of 41, and by the morning of the third day 38 out of 41.

Naphthylamine (2%). This substance is not miscible in water, and had to be dissolved in ammonium oleate, sugar solution being added. By 10 a.m. next morning 34 flies were dead out of 49.

Quassine. An approximately ·4% solution was used, but this substance is rather insoluble. The experiment was started at 4 p.m. and by 6 p.m. 8 out of 68 flies were dead, and at 10 a.m. next morning 48 in all were dead.

Iron perchloride (5%) accounted for 1 out of 32 at 5 p.m. of the first day, and next morning 27 flies were dead. At 2% strength, 1 fly out of 26 was killed by 5 p.m. of the first day, and next morning at 10 a.m. 22 were dead. At a 1% strength, at 5 p.m. 8 were dead and many alive; next morning only 9 dead and many alive.

Iron alum (2%) killed 1 out of 40 by the evening of the first day (experiment started 10.25 a.m.); by 10 a.m. next morning about 50% were accounted for.

Iron fluoride was only fairly soluble in sugar solution. An approximately 2% strength killed 5 out of 30 by 5 p.m. (experiment started 12.50 p.m.); next morning 21 in all were dead.

Allyl alcohol (2%) accounted for 30 dead out of 76 by 6 p.m. (experiment started at 4 p.m.); next morning at 10 a.m. 56 were dead. This substance is too volatile to be of any practical use.

List of compounds tested.

The following list gives all the compounds tested, with the classes in which they are placed indicated by the Roman figures in brackets. Where not otherwise indicated, they were used at 2% in sugar solution; when they failed, they were placed in class III.

Inorganic.

Sodium hydroxide 1% (III).
 „ carbonate 5% (III).
 „ sulphate 5% (III).
 „ acid sulphate 5% (III).

Sodium arsenite (I).
„ fluoride (I).
„ bifluoride (I).
„ iodate (I).
„ periodate (III).
„ borate 4% (III).
Potassium carbonate 10% (III).
„ percarbonate (III).
„ sulphocarbonate (III).
„ ferrocyanide 10% (III).
„ fluoride (I).
„ fluorate (III).
„ chlorate 5% and 10% (III).
„ bromide 5% (III). Killed 100% on fifth day.
„ iodide 1%, 5% and 10% (III).
„ iodate (I).
„ permanganate 10% (III).
Ammonia 2% (III).
Ammonium nitrate 5% and 10% (III). In one case 53% on second day, in another 100% on fourth; three cases failed wholly.
Ammonium persulphate 5% (III).
Ammonia alum 2% and 10% (III).
„ fluoride (I).
„ bifluoride (I).
„ iodate (I).
Magnesium perborate (II).
„ sulphate (III).
Copper borate (III).
„ sulphate (II).
„ ferrocyanide (III).
„ ferricyanide (III).
„ cyanide (II).
Cuprol (II).
Copper acetate 1% (III).
„ phosphate 2% (III). Six dead next day. Many alive.
Zinc chloride 2% (III).
„ sulphocarbolate 1% (III).
Cadmium sulphate (II).
Barium chloride (III).
„ sulphate (III).
„ saccharate ? % (III). Killed 10 out of 11 on third day.
„ fluoride 2% (III). Insoluble; 7 dead out of many next day.
Mercuric iodide 2% (III). Killed 12 out of 32 on third day.
„ bichloride 1% (III).
„ chloride 2% (III).
„ potassium iodide, ·113 gr. per 100 cc. (III).

Lead chromate (III).
,, oxide (Red lead) (III).
,, acetate (III).
,, nitrate (III). Killed 50% on third day.
,, carbonate, 2% and 5% (III).
Phosphoric acid, anhydrous, 2% (III). Eight dead out of many next day.
Phosphorus, red (III).
Phospho-molybdic acid 2% (III); 51 dead out of 63 in one case; 5 dead out of many in second case.
Antimony oxide 2% (III).
,, oxychloride 2% (III); 75% dead on third day.
,, arsenate 5% (I).
Arsacetin 0·1% (III).
Cacodylic acid 0·1% (II).
Paris green 2% (II).
Chromic acid 1% (III). Kills on third day.
Hydrochloric acid 2% (III).
Iodine 5% and 2% (III).
Ferrous sulphate (III).
Iron alum (II).
Iron perchloride (II).
,, fluoride (II).
Cobalt chloride (III).

Carbon Compounds.

Ethyl alcohol 2% and 5% (III).
Amyl ,, 2% (III).
Allyl ,, 2% (II). Kills 80%.
Formic acid 2% (III).
Acetic acid (III).
Butyric acid (III).
Ammonium oleate (III).
Oxalic acid (III).
Tartaric acid (III).
Potassium bitartrate (III).
Ammonium tartrate (III).
Citric acid (III).
Ethyl formate (III).
Magnesium formate (III).
Ammonium formate (III).
Sodium formate (III).
Amyl acetate 1% (III).
Acetamide 2% pure (III).
,, impure (III). Killed by vapour.
Ethyl oxalate (III).
Caffein 2% and 5% (III).

Sodium methyl sulphate 2% (III). Six dead, many alive.
Ammonium tannate (III).
Acetaldehyde 1% and 2% (III).
Saccharin (III).
Acetal (III).
Chloral hydrate 1% (III).
Aldehyde ammonia (III).
Amyl nitrite 1% (III).
Allyl sulphocyanate 0·15% (III).
Mustard oil 2% (III). One-third of females dead on third day.
Calcium cyanamide (III).
Phenol 0·2% (III). Seven flies dead, many alive next day.
Phenetol 4% (III).
Paradichlorbenzene (III).
Toluol parachlorsulphonate 2% (II); 50% dead next day.
Nitrobenzene 4% (III).
Aniline 4% (III).
Sulphanilic acid 2% (III).
Paratoluidine 2% (III). Twenty-one dead, many alive next day.
Orthotoluidine 2% (III). Eight dead, many alive next day.
Methyl aniline 4% (III). Repellent to flies.
Dimethyl aniline (III).
Trimethyl aniline (III).
Phenyl hydrazine hydrochloride 2% (II); 65% dead next day.

Ammonium paradinitrocresylate	2% (I);	50%	dead.
" "	1% (I);	63%	"
" "	0·2% (I);	80%	"
Ammonium orthodinitrocresylate	2% (I);	100%	"
" "	1% (I);	90%	"
" "	0·5% (I);	100%	"
" "	0·2% (I);	90%	"
" "	0·025% (III).	Failed.	
Potassium "	5% (I);	87%	dead.
" "	2% (I);	80%	"

Picric acid 1% (III).
Phenyl acetic acid 2% (III). Four dead, many alive next day.
Benzoic acid 1% (III).
Resorcinol 2% (III). A few died.
Fluorescein 2% (III).
Pyrogallic acid 2% (II); 50% dead.
Tannic acid 1% (III). In one case 58% dead.
Ammonium tannate 2% (III).
Phenol phthallein 2% (III). Four dead, many alive next day.
Salicylic acid 1% (III). Eight dead, many alive next day.
Potassium salicylate (I). See above.
Sodium " (I). " "

Methyl salicylate 2% (III). Failed.
Phenyl „ (Salol) (III). Failed.
Carvone 2% (III). Killed 50% on third day.
Naphthalene 1% and 0.1% (III).
Naphthylamine 2% (II). Killed 66% next day.
Alizarin, alkaline solution, 2% (III).
Quassine 0·4% (II); 60% dead.
Cannabis indica extract 2% (III).
Coumarin, saturated solution (III). In one case 22 dead out of 27; others failed.

Conclusions.

So far as laboratory tests can help, these show that there are substances other than arsenic which will kill flies; and while these may not be effective in areas where flies can get abundant shelter and food, as in France or England, they may be very effective as outdoor poisons in Mesopotamia and Egypt. There is hope that the fluorides, the iodates, the salicylates, iron perchloride and some other substances may replace sodium arsenite in these circumstances, which would be a great advantage, owing to their being less poisonous and their residues forming non-poisonous compounds. It would seem to be worth while testing these chemicals in areas where flies are important; and the knowledge that the salicylates are good, that blue-stone is a possible poison, that iron perchloride is fairly good, might enable a medical officer in a distant place to deal with flies when he could by no possibility get sodium arsenite. The avidity with which flies in Mesopotamia take sodium arsenite makes one think that what are under laboratory conditions quite second-class poisons may there be first-rate ones; and so we publish these results, hoping that they may help the medical and sanitary officer in the solution of this problem. What we should like to urge is that many common drugs and substances, not known to be fly poisons, may be so under conditions where flies are really abundant; and that if iodates, fluorides, salicylates, and the like, are not available, the medical officer should try anything else that is available.

There will possibly be a use for these poisons in hospitals; the fluorides, iodates and salicylates are all excellent for indoor purposes, and used at 1 per cent. in sugar solution are not in any way dangerous or offensive. Formaldehyde is so uncertain that its use is not indicated when any other safe liquid can be employed; the reasons for the variability of its action are now under investigation. For hospital use, particularly, the very small quantity needed makes even the salicylates possible as useful fly-poisons; an ounce of salicylate to five pints of water would poison flies for some time throughout quite a large hospital, and this amount could probably be spared. The fluorides are in use as indoor fly-poisons in the Imperial College, where they successfully destroy flies that escape to the laboratories from the fly rooms.

THE APHID OF TEA, COFFEE AND CACAO (*TOXOPTERA COFFEAE*, NIETNER).

By Fred. V. Theobald.

Nietner in 1880 ("The Coffee Tree and its Enemies") described an Aphis from coffee found in Ceylon and Java as *Aphis coffeae*. The description is as follows:—"Both sexes naked, shiny pitch-black with whitish rostrum and legs and greenish abdomen. The rostrum reaches beyond the base of the second pair of legs. The antennae are 7-jointed, the first, second and sixth being short, the rest long, the two basal joints are black, the rest are whitish, black towards apex. Legs with femora and tarsi nearly black, tibiae nearly white, hind legs with base of tibiae slightly curved. Male four-winged, with black stigma in the upper ones. Female apterous. Abdomen in both sexes 2-corniculate and with an anal tube. Size moderate. Young individuals light coloured." Apparently the male and female described refer to the alate viviparous and apterous viviparous female.

In Vol. II, No. 7, of the "Indian Museum Notes" (1891–93, pp. 34–35), Buckton described an Aphid sent him by Mr. E. E. Green in 1890, which attacked young tea plants in Ceylon, sometimes doing considerable injury. E. C. Cotes writes as follows:—"According to Mr. Green's account, published in the Ceylon '*Independent*' newspaper, both the winged and wingless forms are found in great numbers on the young succulent shoots in nurseries, and the irritation which they set up causes the edges of the leaves to curl and become distorted. . . . The insect is attended by ants."

Buckton examined these insects and sent the following note on the subject:—"The Ceylon Tea Aphis appears to be anomalous and undescribed, and the form has no representative in Europe, as far as I know. In the general appearance of the body, the antennae and the cornicles, it follows the genus *Aphis*, but the single furcation of the cubital vein sharply separates it from that genus, and in this particular it more nearly follows *Schizoneura*. I presume, however, that the Tea Aphis neither rolls leaves nor forms galls, neither has it a flocculent covering. The lower wing also shows some modification in the disposition of the oblique veins. I think it will be desirable to place this Aphis under a new genus, and for the present I suggest for its name, *Ceylonia theaecola*, which is trivial and not therefore binding to any particular character."

The genus and species are described as follows (p. 35):—

"Genus Ceylonia.

"Antennae long and seven-jointed, third and fourth joints nearly equal. Cornicles cylindrical and rather long. Upper wings with the cubitus once forked. Stigma large; oblique veins two. Lower wing with two oblique veins running nearly parallel to each other; tarsus with one joint."

"*Ceylonia theaecola*, nov. sp.

"Colour dark brown to black. Apterous insect, globose, shining, finely punctured. Head square. Antennae long, seven-jointed, ochreous yellow, with

black wings.* Abdomen with a row, on each side, of small pores. Whole insect punctured. Legs dirty ochreous, with dark femora. Cauda black and hirsute; cornicles cylindrical. Size of body 0·055 inch. Winged female coloured much like the above. Wing voluminous, with a brownish membrane much punctured. Under side all brown. Rostrum reaching just beyond the third pair of coxae. Expanse of wings 0·19 inch. Body 0·04 inch. These insects stain weak alcohol a fine port-wine red colour."

This insect is figured in "Indian Museum Notes" (p. 34) under the name *Ceylonia thaecola* in such a rough way as to be of no value, the ratios of the enlarged antennal segments do not agree with the description, and the apterous female "disfigurement" has even no cornicles at all.

However, there is no doubt that this is the Ceylon Tea Aphis and the specific name *theaecola* of the text must stand.

The Belgian Aphidologist, Schouteden, placed the genus *Ceylonia* as a synonym of *Toxoptera* (Ann. Soc. Ent. Belg., xii, p. 230, 1906), and says: "Kirkaldy cite *Ceylonia* comme syonyme de *Myzus*, mais la structure de l'aile est celle de *Toxoptera*. J'espère bientôt pouvoir étudier l'espèce décrite par Buckton."

In the same year Schouteden described a cacao Aphis under the name *Toxoptera theobromae* (Ann. Soc. Ent. Belg., l., p. 38).† Under this name I recorded the Aphid attacking cacao (*Theobroma cacao*) sent me by the Imperial Bureau of Entomology from Southern Nigeria, Kamerun, French Congo and Uganda, and noted that this appears to be the common cacao Aphid of Africa and was also possibly found in the Belgian Congo (Bull. Ent. Res. iv., Feb., 1914, p. 332, fig. 12).

During December 1916, Mr. E. E. Green sent me a number of spirit specimens of Aphids taken on tea and cacao from Ceylon and just previously a slide of a tea Aphid from Assam. A comparison of these showed that the cacao specimens were structurally the same as those from Africa (although most were darker in colour) which I had placed as Schouteden's *Toxoptera theobromae*; and moreover that the typical Ceylon Tea Aphid (and also that of Assam—the so called *Ceylonia theaecola*, Buckton—was the same. The only difference is that the specimens from tea stain, as Buckton says, weak alcohol a deep port-wine red, whilst those from cacao give it no coloration at all. This same Aphid was sent me by the Imperial Bureau of Entomology, taken on coffee at Kampala, in Uganda, by Mr. Gowdey, in August of the same year; these specimens had also to some extent stained the alcohol, but not nearly so much as those from tea. I have also received it from cacao in the West Indies.

From structural characters it seems to me that the common Tea, Coffee and Cacao Aphids (that is, as far as our scanty knowledge goes) are the same, and thus Schouteden's specific name must sink under Nietner's.

Both on tea and cacao this Aphid was dark in the Ceylon specimens sent in alcohol, but both tubes of specimens, in spite of the staining of the alcohol, contained many pale forms, some still showing a distinct green hue, varying from green to a very deep green. The African specimens from cacao were certainly

* This is clearly a misprint for "rings."

† "Un nouvel ennemi du Cacaoyer en Afrique."

nearly all green, but a few were very dark and there seem endless variations in those from Asia and Africa in colour, but very little in structural character. I thus place the Tea, Coffee and Cocoa Aphid as follows:—

Toxoptera coffeae, Nietner.

Aphis coffeae, Nietner.
Ceylonia theaecola, Buckton.
Ceylonia thaecola, Buckton (figure).
Toxoptera theobromae, Schouteden.

The following is a detailed description of the species, which I have drawn up from West Indian, Ceylonese and African material in my collection, taken on tea, coffee and cacao. The colour is more or less taken from notes sent me and the recent spirit specimens received.

Alate viviparous female.

Dark brownish to deep green or paler green on the abdomen, a few with it fawn-coloured. Head, pronotal band and thoracic lobes dark, almost black; the paler abdomen has small dark lateral spots and two dark lines on the venter,

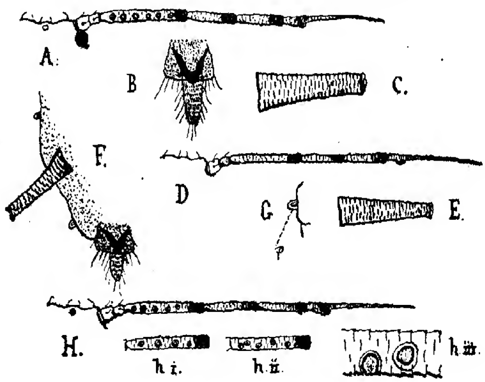


Fig. 1. *Toxoptera coffeae*, Nietn.; A, antenna and head of alate ♀ from tea; B, cauda; C, cornicle; D, head and antenna of apterous ♀; E, cornicle; F, cauda and cornicle: G, pronotal papilla; H, head and antenna of alate ♀ from cacao; *h*.i, *h*.ii, variations of the sensoria; *h*.iii, sensoria further enlarged.

arising from the third pair of black coxae; some have a greener abdomen than others. Cornicles, cauda and anal plate black. Antennae not quite as long as the body, pale, with four dark bands (fig. 1, A and H), one at apex of third segment, another at apex of fourth, one on apex of fifth and another close to it on basal area of sixth; first two segments black or very dark; first wider and longer than the second, the third longer than the fourth, but not so long as the sixth, with 4–6 round, double-contoured sensoria, usually 6 in number; fourth and fifth about equal in length; sixth about as long as 4+5, its basal area about one-sixth the length of the flagellum; third to sixth segments plainly imbricated; some

specimens both from tea and cacao show the flagellum mostly dark, some with the apex only dark. Eyes large, black. Legs moderately long and thick; femora mostly dark, especially the hind pair; tibiae pallid, except at the apices; tarsi dark; apices of femora with a few short hairs and many on the tibiae. Wings (fig. 2) much longer than body; tinged with yellowish brown and dull reddish-brown, paler in those from cacao; stigma large and very dark, almost black, in those from all three host plants; veins yellowish brown; venation subject to some variation (fig. 2, A and B) in each lot sent me. Cornicles (fig 1, C) black, cylindrical, slightly expanding basally, imbricated, nearly as long as the fourth antennal segment. Cauda (fig. 1, B) black, spinose, from a little under one-third to over one-third the length of cornicles, in a few nearly the same length; somewhat bluntly acuminate, with several longish hairs; bluntly conical in a few, owing to retraction. Anal

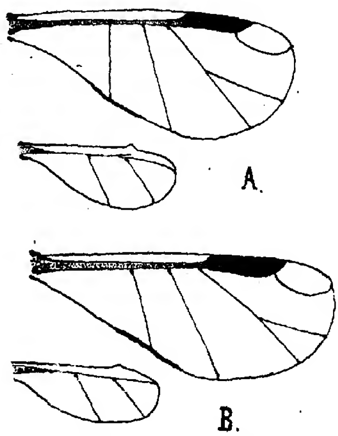


Fig. 2. Wings of *Toxoptera coffeae*, showing two forms which occur in specimens from both tea and cacao.

plate black. A small, but prominent papilla on each side between the cornicles and cauda (fig. 1, F), one on each side of pronotum (fig. 1, G), one between the second and third pair of legs, and one between the third and the cornicles. Ventrally the mesosternum is black and the coxae markedly so, and in some specimens narrow transverse dark bands on venter of abdomen; from the hind coxae arises a black line on each side running to near the end of the abdomen, which has a dark ventral apical plate. Cuticle in front more or less sculptured with hexagonal markings, near the cornicles with linear-marked close ornamentation, varying dorsally and ventrally (fig. 3).

Apterous viviparous female.

Dark brownish to deep green (a few seem to be a paler green), globose, shiny. Head to some extent flattened in front, in some slightly or prominently raised at the base of the antennae and in the middle. The abdomen, which may be paler

than the head and thorax, shows small dark lateral specks. Antennae (fig. 1, D) not quite so long as the body; the two basal segments black; remainder as a rule all pale with four black rings, as in the alate female—in a few the flagellum may be all dark, especially in immature forms; third segment slightly longer than the fourth—in a few markedly longer; fourth and fifth about equal; sixth as long as or slightly longer than 4+5, its basal area about one-sixth the length of the flagellum; all the segments from 3 to 6 imbricated. Cornicles (fig. 1, E) black, thick, cylindrical, slightly expanding basally, about as long as the fourth antennal segment, more or less markedly imbricated. Cauda black, more or less bluntly acuminate, from nearly half as long to nearly as long as the cornicles and with several hairs; in immature forms it is conical. Anal plate black, spinose, and with some long hairs. Legs moderately long and thick; femora mostly black; apices of tibiae black, vest yellowish; tarsi blackish; tibiae and apices of femora with short hairs. A small papilla on each side between the cornicles and cauda; one on each side of pronotum, one between second and third legs, and one between the latter and cornicles (as in fig. 1, F). A few scattered hairs on the body. Eyes large and black. Cuticle ornamented much as in the alate female. Length, 1·6–2 mm.

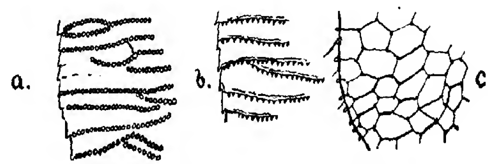


Fig. 3. Ornamentation of the cuticle in *Toxoptera coffeae*, occurring in alate and apterous specimens from both tea and cacao; *a*, area near cornicles; *b*, cuticle of lower surface; *c*, cuticle on anterior part of body.

The proboscis seems variable in specimens from all three host-plants; it may reach or even slightly pass the third coxae, or may end close to the second.

Food-plants. Tea, cacao and coffee.

CEYLON: Peradeniya, 25.x.16; ii.16, on cacao (*E. E. Green*), on tea (*Buckton*), on coffee (*Nietner*); Eltofts, Bogawantalawa, x.16, on tea (*Green*). ASSAM (*G. Watt*), on tea (slide given me by Mr. Green). JAVA. S. NIGERIA (*A. D. Peacock*). KAMERUN: Moliwe, Mabeta, Victoria and Bibundi (*Bussé*). FRENCH CONGO (*Heim*). UGANDA: Kampala, 1.vii.12, on cacao and on coffee, 4.viii.16 (*C. C. Gowdey*). BELGIAN CONGO, on cacao. BRITISH WEST INDIES: Montserrat, amongst cacao flowers, v.11 (specimens from Imperial Dept. of Agriculture).

There is considerable variation in this species from any one of its three host-plants in regard to wing venation, the relative length of the cornicles and proboscis, and in colour. The general facies of the species however seems distinctive, notably the antennal banding and the marked sculpturing of the cuticle. There is certainly a divergence in the antennal sensoria and in the apex of the antennae sometimes being dark, but such variations often occur in many species. The caudal hairs also seem to me to vary to some extent (possibly owing to mounting). Some show only 5–6

hairs on each side, some 3 on one side, 6 on the other, and others seem to have them paired; all show 2 prominently curved ones at the apex and a sub-apical straight one.

There are some discrepancies seen in Schouteden's description of *Toxoptera theobromae* from cacao in Africa, notably that he describes "the antennae with distal part black," and does not mention the marked annulation, and some slight divergence in the ratio of the cauda and cornicles in the apterous female. He speaks of the cauda as being "conical," which seems to point to the description of an immature apterous form. I feel confident, however, that it is only Nietner's *Aphis coffeae*, as all the specimens I have seen from Ceylon and Assam and from Africa on tea, cacao and coffee are undoubtedly the same. There is considerable variation in (i) colour, (ii) the staining effects in alcohol, (iii) the ratio of the cornicles and cauda, (iv) to a slight extent in the sensoria on the third antennal segment, and (v) in the number of the caudal chaetae. But this may be noticed in many other Aphids, such as *A. nerii*, Sch., *A. rumicis*, F., *A. gossypii*, Glover, etc., both as regards colour and antennal sensoria, these being all species which live on many host-plants.

OBSERVATIONS ON SCALE-INSECTS (COCCIDAE)—III.

By Robert Newstead, F.R.S.,
The School of Tropical Medicine, The University, Liverpool.

(Plates VI and VII).

Platysaissetia carpenteri, sp. nov.

Female, adult. More or less circular or faintly pentagonal; low convex; pseudo-margin strongly rounded, giving the insect a markedly "crustliform" (Green) appearance; margin very thin and shallow; anterior stigmatic clefts well defined. Dorsum with a slightly subcentral depression, from which there arise *strong radial striae* extending to the pseudo-margin. Anal cleft fused. Anal lobes in the sub-central depression, so that they appear almost in the middle of the back. Colour of dorsum brownish black, with minute reddish-buff glandular spots. Venter coffee-brown. Detached scurfy particles of a somewhat glassy secretion within the pseudo-margin, and six larger particles of similar material, each resting upon a minute tubercle, arranged in a parallelogram near the central depression. Derm cells closely packed together, very irregular in shape, many being markedly attenuated at one extremity; these are divided into more or less definite radial bands corresponding to the spaces between external striae; in the central area of the dorsum they are almost obscured by the dense chitin, so that only the minute central pores are traceable; in this same area are a number of larger and clearer pores varying considerably in size, the larger ones radiating from the anal lobes.

Length, 101–0·5 mm.

Female test, second stage. Completely covering the whole of the upper parts of the body; opaque, glassy white, and finely vesicular; divided into median, sub-median and marginal rows of relatively large, imbricated plates; extreme margin with portions of a fringe of fibrous matter of a similar nature to that which forms the test proper.

Length, 2·2 mm.; width, 1·7 mm.

The above diagnosis was drawn from the *ventral* surface of a single specimen which had fixed itself in one of the large stigmatic clefts of the type female.

Female, second stage. Elongate-ovate; margin faintly wavy. Legs and antennae highly developed; the latter (fig. 1, *a*) of six segments; 3rd very long, equalling the length of the last three together; formula: 3, 2 (4, 6), 1, 5. Legs longer than the antennae; tarsi shorter than the tibiae; femora rather incrassate. Stigmatic clefts obsolete. Stigmatic spines three, laterals with the tips rounded, nearly half the length of the median one; the latter also bluntly pointed. Marginal spines acute, of about the same length as the lateral stigmatic spines, but broader at the base; they are placed rather closely together; those at the angles of the anal cleft about three times the length of the others. Glands of five different types: (1) small, faintly 8-shaped or ovoid, with a faint central bilateral constriction; these occur in advance of the marginal spines and extend over the whole of the venter in large

numbers; (2) long tubular glands (fig. 1, *b*) thickly disposed over the venter; (3) irregular ovate glands, with minute obscurely 8-shaped pores, collectively forming a faint polygonal reticulation dorsally; (4) relatively large and irregularly lobate glands (fig. 1, *c*) extending from the anal lobes to the rostrum on both sides of the median line; and (5) a regular submarginal series of very large tubular glands (fig. 1, *d*) each with an inner, somewhat flask-shaped tube; of these there are eleven on one side and twelve on the other; in many instances they are placed opposite a faint depression in the margin. A median strip of dark chitin extends from the rostrum to the anus. Anal lobes with the basal and outer margin in one continuous curve, inner edge straight. Anal cleft short, open.

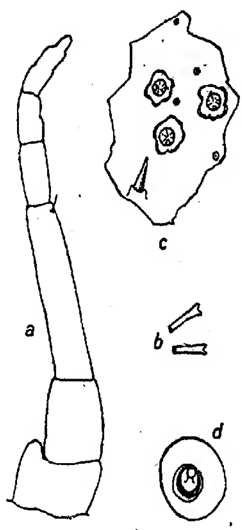


Fig. 1. *Platysaissetia carpenteri*, Newst., sp. n., ♀; *a*, antenna; *b*, *c*, *d*, glands and pores.

Length, 2·1 mm.; width, 1·7 mm.

UGANDA: Ngamba Is., on the trunk of a fig tree, 16.v.14 (*Dr. G. D. H. Carpenter*).

The adult female differs from *P. castilloae* (Ckll.) in having the anal lobes (operculum) placed near the centre of the dorsum, and in the presence of dorsal radial striae. The second stage female differs in the larger number of submarginal glands.

Platysaissetia ferox, sp. nov.

Female, adult. Dorsal area with rather conspicuous, granular, amber-yellow patches of secretion arranged, more or less, in concentric and narrowly ovate rings. Pseudo-margin with a series of toothlike, glassy appendages, varying in colour from amber-yellow to translucent grey; there are 10–12 of these appendages on either side.

Length, 2·8–3·2 mm.; width, 2·2–2·4 mm.

Female adult (denuded). Short ovate or roughly quadrate; dorsum generally keeled, the sides sloping sharply downwards; pseudo-margin strongly crenulated or wavy, each depression corresponding to the position of the toothlike appendages; derm exceedingly dense and hard, surface polished and faintly uneven; colour piceous, with here and there traces of the closely packed glands showing as yellowish spots. On the ventral surface *below the crenulated pseudo-margin* is the true margin in the form of a prominent ring of chitin upon which the insect rests, and as this is thickened at both extremities it gives the insect a slightly tilted appearance, and also raises the pseudo-marginal appendages, so that the latter present a semi-detached appearance. At gestation the extremely thin ventral derm shrivels, leaving a central hollow, as in certain species of *Lecanium* and *Ceroplastes.* Antennae partly atrophied, of (?) six segments, the terminal segment with several short stout hairs. Legs of about the same length as the antennae; tarsus either equal to or very slightly longer than the tibia. Anal cleft very clearly defined, but fused. Anal lobes small, with the base and outer edge in a continuous curve; inner edge straight; a single minute hair in advance of the middle line and a similar one at the apex. Derm glands similar to those in *Lecanium* (*Saissetia*) *hemisphaericum*, but so densely packed as to give the derm, by transmitted light, an imbricated appearance; glands of the fringe-bearing incrassated body-wall, or pseudo-margin, very long and somewhat tubular in shape; they are very closely packed together and superimposed. Here and there, in the hollows of the undulations, one may trace the large cylindrical gland which forms so conspicuous a feature in the earlier stages. Anterior stigmatic clefts strongly pronounced; no trace of the second pair.

Length, slightly smaller than the test.

Female test, young adult. Bright golden-yellow or amber-yellow; dorsal area somewhat irregularly granulated, some of the larger granules roughly cube-shaped; tooth-like process forming the fringe as in the adult, but smaller and uniform in colour with the dorsum.

Female, young adult. Colour of dry integument pale castaneous or yellowish brown; eyes piceous. The pseudo or fringe-bearing margin (fig. 2, *a*) similar to that of the old adult, but not nearly so prominent and the undulations less pronounced; in each of the hollows of the crenulations is a large cylindrical pore (fig. 2 a_1) enclosing a large spinose squama similar to those found in the DIASPINAE; in addition to these the derm is closely packed with longer and larger glands (fig. 2, a_2) roughly tubular in form, arranged transversely two to three deep and overlapping each other; they are, however, irregular in shape and but faintly indicated. Scattered over the ventral surface are a number of minute circular pores. The true margin is furnished with a regular series of closely set spines (fig. 2, a_3) and immediately in advance of them minute circular pores, arranged more or less in line with the spines. Derm cells in the non-chitinised portion of the dorsum, just within the margin proper (fig. 2, *a*), forming an irregular polygonal tessellation. Legs very short, tarsus slightly longer than the tibia. Antennae broken away in the preparations.

Female (?), *second stage.* (No test present in either of the two examples examined). Form broadly ovate. Pseudo-margin absent. Anal cleft well defined, but relatively

short; anal lobes similar to those in the adult. Margin (fig. 2, *b*) continuous. No stigmatic clefts. Stigmatic spines (fig. 2, *b*) three, the laterals short, stout and obtuse, the central one more than twice the length of the former. Marginal spines (fig. 2, *b*) slightly larger than those in the adults. Tubular glands well within the margin; there are eleven of these on either side and one opposite the centre of the cephalic margin with a much smaller gland on either side of it; just within the angles of the anal cleft is a similar small gland. Post-anal pores (fig. 2, *c*) circular, with confused gratings; these are arranged in two scattered groups numbering six and five respectively; on the rest of the mid dorsal area are numerous minute circular pores, and a few rather slender spines. Derm cells in a broad marginal zone, forming a polygonal reticulation in the stained specimens. The legs and antennae had been almost entirely removed by a predaceous larva of some kind, whose frass was found beneath the body of the Coccid.

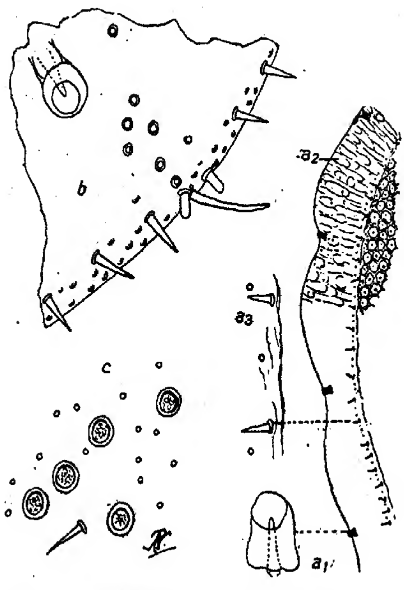


Fig. 2. *Platysaissetia ferox*, Newst.; *a*, margin of young adult ♀; a_1, gland; a_2, gland pores; a_3, inner series of spines; *b*, margin of second stage ♀; *c*, postanal pores of the same.

Length, 1·3 mm.; width, 1·1 mm.

Larva. Anal lobes well within the cleft, the apical hair long; two laterals much shorter; there is also a single minute spine seated on the inner edge in a marked depression. Antennae and legs robust; the former of six segments, the 3rd about twice the length of the 2nd. Marginal hairs extremely small. Stigmatic spines three, the laterals exceedingly minute; the central one very long and equal in length to the third segment of the antennae. No special dorsal or marginal glands traceable.

S. NIGERIA: Calabar Botanical Gardens, on a hard-wooded scrub, 15.iv.08 (*Dr. Slater Jackson*).

This is altogether a very remarkable species, bearing a striking superficial resemblance to an immature example of a Monophlebid of the genus *Lophococcus*. The crenulated pseudo-margin is however suggestive of certain species of *Ctenochiton*; but it is certainly not congeneric with the latter, and is, I feel, correctly placed in *Platysaissetia*.

Akermes andersoni, sp. nov.

Female, adult. Completely covered with a rather dense, dusky-white, mealy secretion, which also spreads over the surrounding portions of the food-plant, giving the infested leaves an almost uniform mealy appearance. Colour, on the removal of the secretion, rich dark piceous or very dark castaneous, shining; younger examples varying from reddish brown to dusky buff. Form irregularly oval, asymmetrical, and more or less narrowed in front; sometimes broadly ovate or subcircular. Flat or very low convex with a faint median keel in the abdominal region; sides well within the margin, with a series of widely separated *truncate tubercles*; these structures vary in number and are often also asymmetrical. Derm densely chitinised, more especially so towards the margins, where innumerable minute, translucent, poreless "cells" are present.

Female, young adult. (fig. 3, *a*). In this stage all the structural details are clearly demonstrated; they do not differ from those of the older examples. Antennae (fig. 3, *b*) rudimentary; articulations somewhat irregular and not very clearly defined, five segments being traceable in some individuals; 1st segment with a few minute hairs; the terminal one with five to six stout spinose hairs; length, inclusive of hairs, about equal to the length of the anal lobes. Front pair of legs (fig. 3, *c*) represented by extremely minute tubercular projections, each furnished with a minute spine—the rudiments of a claw; these structures measure about one-third the total length of the stigmata. Anal cleft short but well defined. Anal lobes roughly triangular, inner edge longest, straight; base shortest; beneath each is a well defined sclerite. Anal ring with eight hairs. Derm immediately above the anal orifice with a series of circular pores and usually four minute spines. Stigmatic clefts (fig. 3, *d*) generally quite minute, but occasionally there is a great indentation of the margin in this region (? due to arrested development by prominent bodies of the food-plant); stigmatic spines (fig. 3, *d*) three, all very small, the central one the longest. Margin with a complete fringe of very long and relatively stout hairs, and just within them is a widely separated series of minute hairs. The "truncate tubercles," as seen on the dorsum of the dried specimens, when examined in optical section, show that the ends are composed of numerous circular or ovate pores. In addition to the large compound pores (fig, 3, *e*) there are also a few much smaller ones, but their number and arrangement varies in different individuals and they are moreover asymmetrical. Stigmata (fig. 3, *f*) somewhat trumpet-shaped in some individuals, in others, especially when seen in profile, with a trifoliate flange and a central spheroid process.

Length, 2·5–3 mm.; width, 2–2·2 mm.

Female, second stage. Elongate ovate. Antennae similar to those of the adult but shorter. Cribriform plates in two examples arranged as follows $\frac{1}{3-3}$ $\frac{0}{3-3}$; they are all approximately of the same size as the smallest in the adult. Marginal spines like those of the adult, but much more widely separated. Anal lobes elongate, apex with one very long hair and two to three much shorter ones. Anal ring of (?) eight hairs. No trace of rudimentary legs.

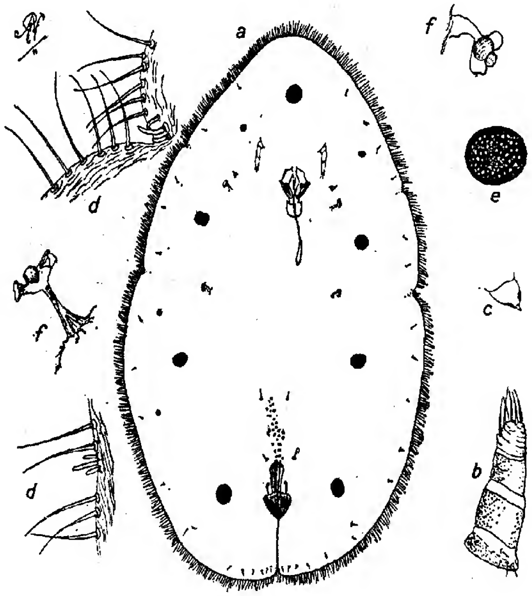


Fig. 3. *Akermes andersoni*, Newst., sp. n., ♀; *a*, adult ♀; *b*, antenna; *c*, rudimentary leg; *d*, stigmatic and marginal spines; *e*, compound pore; *f*, stigmata.

Larva. Antennae of six segments; 3rd the longest. Margin of body with long equidistant hairs. Stigmatic spines three, the central one of great length, the laterals minute. Anal lobes conspicuous, each with an immense seta, and one or two small ones. Anal ring with six hairs. Cribriform plates absent.

British East Africa: Kabete, on orange leaves (heavy infestation), i.1914 (*T. J. Anderson*).

One has experienced no little difficulty in assigning this remarkable Coccid to its proper generic position; but as it fits best into Cockerell's genus *Akermes** I have placed it there provisionally. In some respects it agrees with *Hemilecanium*, Newst.,† but in this the anal cleft is obsolete and the compound pores are present in all stages.

* Canad. Ent. XXXV, pp. 89–90 (1902).
† Jour. Econ. Biol. III, p. 39, pl. iv (1908).

Akermes quinquepori, sp. nov.

Female, adult. Flattened and shrivelled on the dorsum; sides somewhat rounded and thickened; integument presenting a dull, oily appearance; colour, when dry, dull red-brown, sometimes paler on the dorsum and often with obscure blackish and indefinite markings. Antennae (fig. 4, *a*) and legs (fig. 4, *b*) vestigial; the former with several short spinose hairs at the tip; basal segment relatively very large; length less than half the width of the stigmata. Legs (fig. 4, *b*) about the same size as the antennae; coxal sclerite relatively large, claw well defined; above the latter a slender hair, and there are several additional hairs traceable in some of the

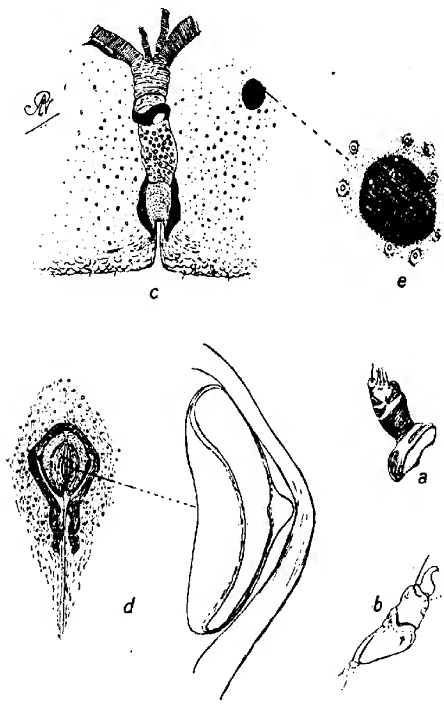


Fig. 4. *Akermes quinquepori*, Newst., sp. n., ♀; *a*, rudimentary antenna; *b*, rudimentary leg; *c*, stigmatic area; *d*, anal lobes; *e*, large compound pore.

specimens. Stigmatic clefts (fig. 4, *c*) deep; at the base a strongly chitinised sclerite which forms a semicylindrical tube; from this structure to the stigmata is a thin glandular tube; the whole of this respiratory organ is unusually large. Margins thickened and finely but irregularly crenulated; spines exceedingly minute and irregularly arranged. Anal cleft short, about one-sixth the entire length of the insect. Anal lobes (fig. 4, *d*) surrounded by a thickened wall of chitin and beyond it a concentric zone of thinner chitin beset with rather small and somewhat circular

pores; lobes very thick, basal outline somewhat horn-shaped and at the angle formed by the juncture of the base and outer edge is a well defined tubercular projection. Submarginal compound pores (fig. 4, *e*) very large and presenting an exceedingly minute reticulated surface; these are arranged as follows: one, the largest, about midway between the base of the rostrum and the margin; one in front of, and another between each of the spiracles, making five in all; these structures are possibly analagous to the "cribriform plates," but have much finer gratings. Derm of both dorsum and venter thickly set with minute ovate glands, each with a circular opening having a well defined chitinous ring.

Length, 3·8–5 mm.

Larva with well developed legs and antennae.

British Guiana: Georgetown, on *Microlobium acaciaefolium*, 28.xii.13 (*G. E. Bodkin*).

Mr. Bodkin also adds the following details: "This Coccid was discovered beneath the bark of a tree growing in the Botanic Gardens. It was attended by a small black ant which occurs commonly, especially under the bark of trees. The bark could be easily removed with a knife. The Coccids were observed to occur in small colonies of two to three or three to five together. They were apparently entirely hidden from the light. The colour of the adult females, when alive, is dull pink. The young larvae are bright pink in colour and extremely active. Ova are produced by the female." (*In litt.* 3.i.14).

Lecanium hirsutum, sp. nov.

Female, adult. Short ovate, rarely sub-circular; integument thin; colour in alcohol dusky yellowish-white to ochraceous buff, margin usually distinctly darker. Integument of the dorsum clothed with long spinose hairs and thickly studded with glands (fig. 5, *a*), the central orifice of the latter surrounded by several somewhat irregular lobate processes. Antennae (fig. 5, *b*) rather short and stout, of seven or eight segments, usually eight, of which the third is the longest. Legs stout; tarsus (fig. 5, *c*) much shorter than the tibia; claws short and very broad proximally; upper digitules long and rather stout, distal extremity distinctly dilated and flattened; lower digitules unusually *broad and flat.* Stigmatic cleft (fig. 5, *d*) well defined and much wider proximally than distally; spines short, seven to nine in number, three or more being much stouter than the rest, but not all arranged in the same plane. Marginal hairs numerous and similar to those on the dorsum, into which they merge imperceptibly; close up to the bases of many of these are two distinct pores (fig. 5, *a*). In the young adult females the margin (fig. 5, *f*) is also *thickly set with short stout spines,* but these organs are so easily deciduous in the old adults that they are rarely present. Anal lobes (fig. 5, *e*) with the base as long as the outer edge; apex with an unusually long hair. Hairs of the anal ring extremely short, being scarcely as long as the lobes.

Length, 3–4 mm.

East Africa; food-plant not stated. (Ex coll. Berlin Zoological Museum, 1912).

This insect resembles *Lecanium* (*Eulecanium*) *pubescens*, Ehrhorn,* in having the dorsum clothed with hairs, but in all other respects it is markedly distinct, the salient characters in *L. hirsutum* being the strongly invaginated stigmatic clefts, the curious and unusual shape of the digitules of the tarsi and the innumerable small spines and hairs at the margin.

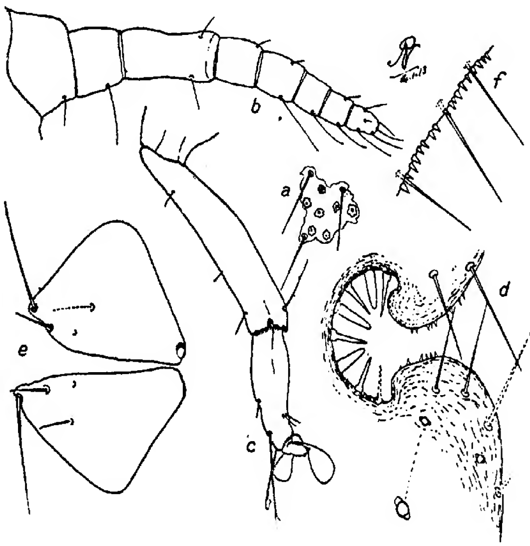


Fig. 5. *Lecanium hirsutum*, Newst., sp. n., ♀; *a*, portion of integument of dorsum; *b*, antenna; *c*, leg; *d*, stigmatic cleft and spines; *e*, anal lobes; *f*, marginal spines of young adult.

Lecanium pseudotessellatum, sp. nov.

Female, adult. Very broadly ovate or sub-circular; margin broadly flattened; dorsum low convex. Median and sub-median carinae interrupted by lateral, radial carinae; the last-named very clearly defined and equidistant at the margins. The somewhat rectangular spaces enclosed by the carinae, in old examples, with a relatively deep and large depression, giving the dorsum a more or less tessellated appearance. Small detached patches of glassy secretion in the hollows of the dorsum and margin. Colour variable: pale castaneous, with a clearly defined darker margin and irregular blackish markings in the centre of the dorsum, or dull castaneous with a darker margin; young adults are much paler. Antennae (fig. 6, *a*) robust, of seven segments; the 3rd very slightly longer than the 2nd; 6th with a rather stout spine; formula: 3, 2, (5,6), (4,7), 1: Legs unusually large; tibia and tarsus (fig. 6, *b*) together equalling the length of the antennae; tarsus slightly thicker than the tibia; lower digitules very robust. Anal cleft slightly less than one-fifth the length of the body. Anal lobes (fig. 6, *c*) somewhat diamond-shaped; base

* Canad. Ent. XXX, p. 244 (1898).

relatively straight and longer than the outer edge; a series of submarginal hairs, usually five, on the inner edge; tips with two or three similar hairs; ventral sclerites conspicuous. Anal ring with six very stout hairs, and on either side a single, very long hair. Dorsal glands with circular pores extending in a relatively broad band between the anal lobes and the rostrum, and continuous along the outer edge of the lobes. Stigmatic clefts (fig. 6, *d*) invaginated and asymmetrical, the three spines pushed to the lower side of the enclosed space. Derm glands at the margin irregularly ovate, and arranged more or less in radial bands. *Venter with a broad,*

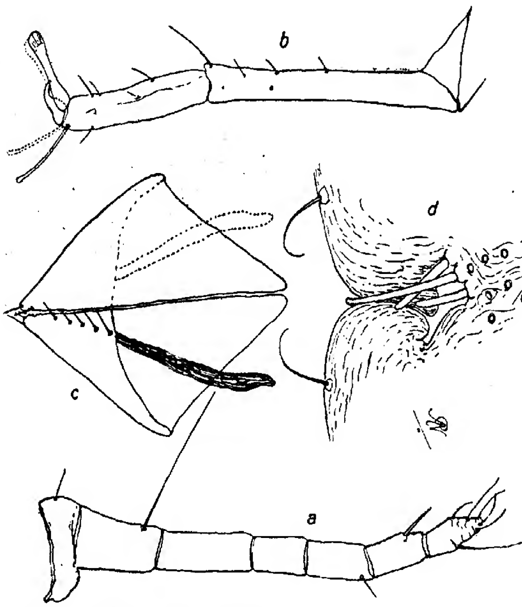


Fig. 6. *Lecanium pseudotessellatum*, Newst., sp. n. ♀; *a*, antenna; *b*, leg ii.; *c*, anal lobes; *d*, stigmatic cleft.

continuous, submarginal zone of tubular glands. Marginal hairs very long and generally markedly curved somewhat like a fish-hook. Old examples completely covered with a dense soot-like fungus.

Length, averaging, 3·7 mm.

Male. Head, thoracic sclerites and costa of wings, pale castaneous; apodeme piceous; abdomen and legs pale brick-red.

Male puparium. Glassy; relatively very broadly ovate; divided into three bilateral, one cephalic and two median plates, the *inner* edges of the ridge dividing the median from the lateral plates finely but distinctly crenulated.

Length, 2·2–2·3 mm; width, 1·5–1·6 mm.

TRINIDAD: Aripo Savana, on *Chrysobalanus pellocarpus*, Mey., ii. 1915 (*W. A. Freeman*, per F. W. Urich).

Lecanium wardi, sp. nov.

Female, adult. Irregularly ovate, somewhat pyriform or more or less deltoid; flat and thin or very low convex. Dorsum wrinkled; sides coarsely punctate, and with fine, widely separated, radial ridges. Derm with radial bands of pigment, most pronounced in the abdominal region. Gland pores relatively large, ovate or circular, and so arranged that they form collectively a large polygonal reticulated pattern; they are most conspicuous in the dorsum, but can also be traced, chiefly between the pigment bands, almost to the margin. Marginal spines (fig. 7, *a*) placed

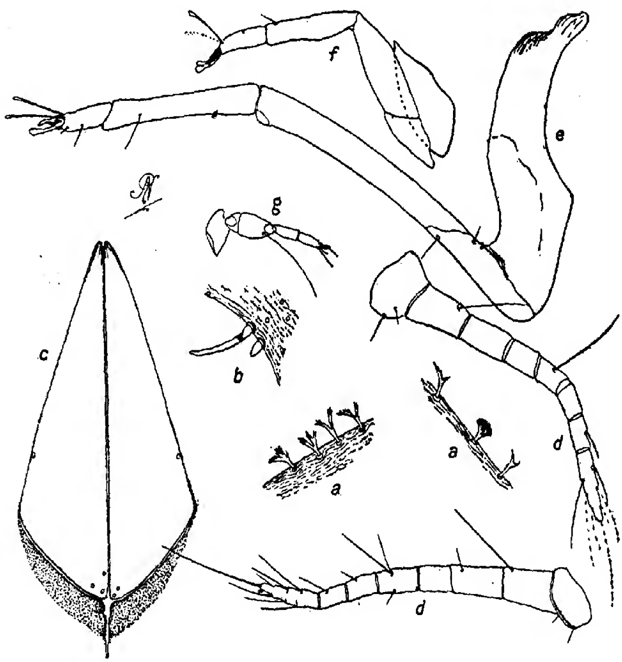


Fig. 7. *Lecanium wardi*, Newst., sp. n., ♀; *a*, marginal spines; *b*, stigmatic spines; *c*, anal lobes; *d*, antennae of second stage ♀; *e*, leg iii.; *f*, leg i.; *g*, leg iii. of larva.

closely together, short, deeply divided and frayed; palmate forms also occur at rare intervals. Stigmatic spines (fig. 7, *b*) three, the laterals small and conical, as in certain species of *Ceroplastes*. Anal lobes (fig. 7, *c*) strongly attenuated along the proximal edge. Anal ring of six hairs. Anal cleft about one-third the length of the body. Antennae (fig. 7, *d*) of eight segments; 2nd, 5th and 8th each with a very long hair; the formula varies slightly, but the 2nd, 3rd and 8th are much the longest. Legs well developed.

Length, 3–3·6 mm; width, 2–2·8 mm; length of anal cleft in large specimens, 1·3 mm.

Female, second stage. Exceedingly thin and paper-like. Colour dusky white or pale greyish-buff. Form generally ovate. Antennae of six segments, 3rd and 6th much the longest. Legs robust. Marginal spines as in adult.

Male, second stage. Ovate. Antennae relatively longer than those of the preceding stage, of six segments; 3rd much the longest, and decidedly longer than the 6th. Marginal spines and anal lobes similar to those of the female. Second and third pairs of legs (fig. 7, *e*) *more than twice the length of the first pair* (fig. 7, *f*).

Larva. Marginal hairs stout and curved, the tips almost reaching the bases of the succeeding hairs; 2nd and 3rd pairs of legs (fig. 7, *g*) with an exceedingly long hair towards the tip of the femora, being slightly longer than the tibio-tarsal segments together.

BRITISH GUIANA: Botanic Gardens, Georgetown, on leaves of Malacca Apple, 28.vii.15 (*R. Ward*).

A very large percentage of the Coccids were infested by a fungus.

Lecanium aequale, sp. nov.

Female, adult. Dull olivaceous brown, brownish-black, or piceous, surface shining, as if coated with partly absorbed varnish. Form ovate, slightly elongate-ovate, or subpyriform. Dorsum with a median interrupted keel and somewhat

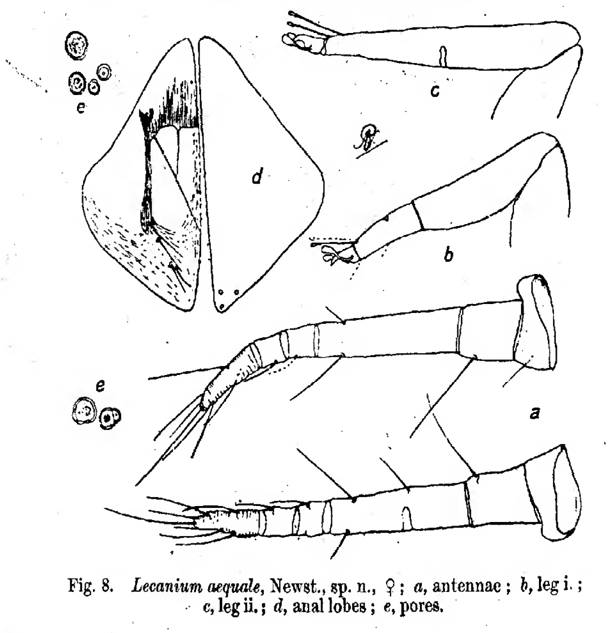


Fig. 8. *Lecanium aequale*, Newst., sp. n., ♀; *a*, antennae; *b*, leg i.; *c*, leg ii.; *d*, anal lobes; *e*, pores.

irregular, faint, transverse ridges. Antenna (fig. 8, *a*) of *six* segments, the 3rd often with an imperfect central division, as long as or slightly longer than the three succeeding ones. First pair of legs (fig. 8, *b*) with the tibio-tarsal articulation

apparently complete, but usually faintly indicated; tarsi with a marked indentation 2nd and 3rd pair of legs; (fig. 8, *c*) with the tibio-tarsal articulation imperfect, and usually indicated by a thinning of the chitin on the lower half only. Anal lobes relatively large (fig. 8, *d*), with the basal edge much longer than the outer; the tips, externally, show three spine attachments; ventral sclerite with one proximal and two distal, long, spinose hairs. Anal ring of six hairs. Anal cleft fused, excepting a small portion towards the margin; length a little less than one-fourth the length of the body. Derm cells with minute clear pores, very thinly scattered over the whole of the dorsum. There are two long post-anal hairs, and immediately in advance of them, a very scattered group of pores (fig. 8, *e*); but these entirely disappear in very old examples. Marginal spines simple, slender, and curved. Stigmatic spines three, central one much the longest. Stigmatic clefts faintly indicated.

Length, 1·7–2 mm.

Female, second stage. Ovate. Antennae resembling those of the adult; but the 4th and 6th segments are sometimes fused, so that in such instances only five segments exist; one example possesses both forms of antennae. Tibio-tarsal articulation in legs ii. and iii. usually a little more pronounced than in the adult. Anal ring with eight hairs, two smaller than the rest. Post-anal pores (fig. 8, *e*) extending midway between the anal lobes and the rostrum; there are from 18-20 of these, varying in shape and size and some of them coalescing. A few short spinose hairs scattered thinly over the whole of the dorsum. Stigmatic spines three, the median one of great length. Stigmatic clefts faintly indicated. Anal cleft apparently fused.

Male puparium. Glassy in texture, relatively broad, divided into nine plates: one cephalic, three bilateral, two dorsal.

Length 1·2–1·3 mm.; width, 0·75 mm.; thus, compared with the size of the adult females, the puparia are, relatively speaking, exceptionally large.

British Guiana: Sea shore, East Coast, on "Coupida" (*Avicennia nitida*), 30.v.15 (*G. E. Bodkin*).

This is apparently a viviparous species, as embryo larvae were found in two of the examples. Distinguished by its unusually small size, and the fusing of the tibio-tarsal segments in legs ii. and iii.; the number of segments to the antennae (six) is also somewhat unusual. It is clearly distinct from Cockerell's *Lecanium* (*Coccus*) *nanum*, and *L. rubellum*. My colleague, Mr. E. E. Green, to whom examples were sent in the first instance, has asked me to describe this species. I have pleasure in doing so and have adopted the MS. name which he gave it.

Lecanium acaciae, sp. nov.

Female, adult. Elongate, highly convex on small twigs; low convex on the larger branches and sometimes irregularly keeled along the median line; often shrivelling considerably after death. Colour bright ochraceous, reddish buff, or dull castaneous, rarely with a faint pigmented reticulation; eyes black. Antennae (fig. 9, *a*) usually of eight segments; immediately below the articulation of the 4th and 5th segments is an extremely long outstanding bristle; a rather long slender spine arising from

each of the 6th, 7th and 8th segments; 8th with several long stiff bristles; formula: (3,4), (8,2), 1, (6,7), 5; examples with seven segments (fig. 9, *b*) are exceptional, and in such instances there is a partial articulation in the region of the outstanding bristle on the fourth segment. Legs: tarsi usually with a well defined, dorsal constriction towards the distal extremity, from which arises a minute hair; tarsal digitules very long, stout, and slightly dilated; those of the claw stout and strongly dilated; claw short and stout. Stigmatic clefts (fig. 9, *c*) faintly indicated; spines three, the central one a little more than twice the length of the laterals, stout, pointed, and strongly curved. Marginal spines (fig. 9, *c*) comparatively stout, curved and divided or frayed distally. And lobes (fig. 9, *d*) approximately triangular, inner edge longest, apices bluntly pointed; a well developed chitinous paraphysis

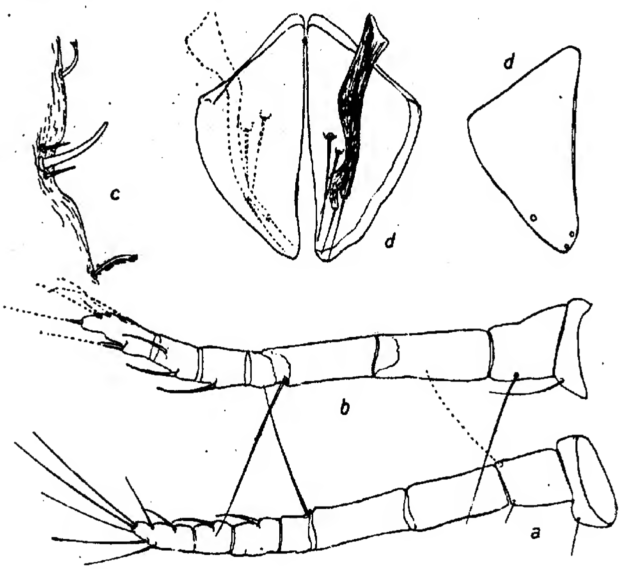


Fig. 9. *Lecanium acaciae*, Newst., sp. n., ♀; *a*, *b*, antennae; *c*, stigmatic and marginal spines; *d*, anal lobes.

or sclerite beneath each lobe furnished with two stout bristles; ventral eversile sac with four stout hairs; anal ring with six hairs. Derm with thinly scattered, small, oval, and also a few large translucent cells.

Length of dried examples, 3·5–5·2 mm.

Male puparium. Glassy, normal in form; but the number of plates into which it is divided not ascertainable from the rather poor material at hand.

British East Africa: Nairobi, on *Acacia melanoxylon* and *Albizzia moluccana*, i. 1914 (*T. J. Anderson*).

This Coccid had been preyed upon by the larvae of a Lepidopterous insect, whose compound cocoon was covered with dead females.

Lecanium adersi, sp. nov.

Female, adult. Very flat, irregularly ovate, and narrowed in front. Colour varying from chocolate-brown to brownish buff. Antennae (fig. 10, *a*) of six or seven segments; in the latter the 4th is much the longest; in some examples the articulation of the 3rd with the 4th is very faintly indicated or entirely absent. Legs long and slender, especially the middle and hind pairs. Stigmatic clefts (fig. 10, *b*) invaginated; stigmatic spines stout, bluntly pointed and of varying lengths; there are from twenty to twenty-two of these organs. Marginal spines (fig. 10, *c*) falciform and finely serrated on one side. Anal lobes (fig. 10, *d*) with the base exceedingly

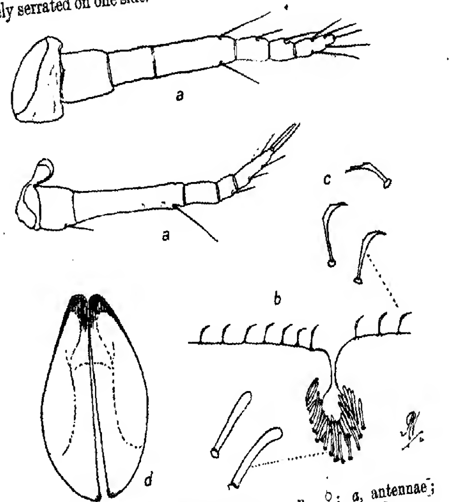


Fig. 10. *Lecanium adersi*, Newst., sp. n., ♀; *a*, antennae; *b*, stigmatic cleft; *c*, marginal spines; *d*, anal lobes.

short, and the outer edge very long and strongly curved or arched. Anal cleft about one-fifth the length of the body. Derm cells minute and very widely separated; there are, however, several of these or similar organs grouped together just in front of the anal orifice.

Length 4·75–5·50 mm.

ZANZIBAR: Marahubi, on mango leaves, 24.iv.13. (*Dr. W. M. Aders*).

Closely allied to *Lecanium bicruciatum*, Green,* from which it differs chiefly in the multiplication of the stigmatic spines.

Lecanium africanum, Newstead.

Lecanium viride var. *africanum*, Newstead, Ent. Mo. Mag. (2) ix, p. 95 (1898).

Lecanium viride (Green), Newstead, Bull. Ent. Res. i, p. 187 (1910).

Female, adult. Colour of dried specimens often yellowish green; others are bright ochraceous, straw-coloured or pale reddish-brown; eyes black. Dorsum,

* Cocc. Ceyl. iii, p. 214, 1. LXXVI.

especially in the younger forms, with a series of black markings, often forming a narrow loop-like pattern; these markings are however rarely present in very old examples. Form oblong oval, but the outline is often irregular; narrowed in front and moderately convex, but the margins broadly flattened, especially the cephalic portion. Antennae (fig. 11, *a*) of eight segments, rarely of seven; formula of the former: 3 (2, 4, 5, 8) 1 (6, 7); there is a very long hair on the 2nd and 5th segments, and several shorter ones on the 8th, 6th and 7th, each with a distinctly stouter hair. Legs normal, though the anterior tarsi sometimes exhibit a faint, dorsal constriction. Anal lobes (fig. 11, *c*) attenuated distally, inner margin longest; apices with a few fine short hairs. Anal cleft slightly less than one-third the length of the body. Stigmatic cleft (fig. 11, *b*) very slight, sometimes scarcely

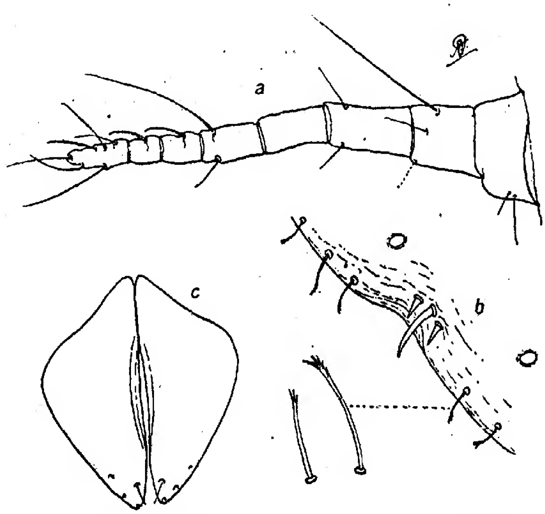


Fig. 11. *Lecanium africanum*, Newst., ♀; *a*, antenna; *b*, marginal and stigmatic spines; *c*, anal lobes.

visible; spines three in number, rather small, the central one being about three times the length of the laterals. Marginal spines (fig. 11, *b*) small, generally slightly curved and faintly fringed distally. There are three to four hairs of varying length near the attachment of each of the antennae, and usually four rather longer and stouter ones just in advance of the anal lobes. Derm cells oval and markedly distinct in stained preparations, but scarcely visible in unstained specimens.

UGANDA: Chagwe, on coffee, 12.xi.12 (*C. C. Gowdey*).

This insect is specifically identical with the examples recorded by me in this Bulletin (*l.c.*) as *Lecanium viride*, Green. At the time I called attention to the fact that the specimens submitted by Mr Gowdey differed from typical *L. viride* in having the derm cells placed more closely together, and that there was an entire absence of circular wax-glands surrounding the genital orifice. I now find that

although the latter are traceable in some examples, there are other marked differences; in the first place, the antennae consist normally of eight segments a character not noted in *L. viride*; and secondly, the form of the anal lobes is quite defferent. In the light of these important differential characters, I have given this insect specific rank.

Judging by the heavily infested leaves of the food-plant, this Coccid must cause serious injury to the coffee under cultivation in Uganda. It may be interesting to add that the examples from which I drew up the original diagnosis of *Lecanium (Coccus) viride* var. *africanum* came from Lagos, West Africa, and that they also occurred on coffee leaves.

Lecanium cajani, sp. nov.

Female, adult. Very elongate, with a faint median abdominal keel; cephalic area wrinkled; sides with faint radial ridges. Marginal spines covered with a glassy secretion and forming a very faint fringe. Middle area of dorsum covered with an extremely thin pinkish white secretion, which presents a hard even surface

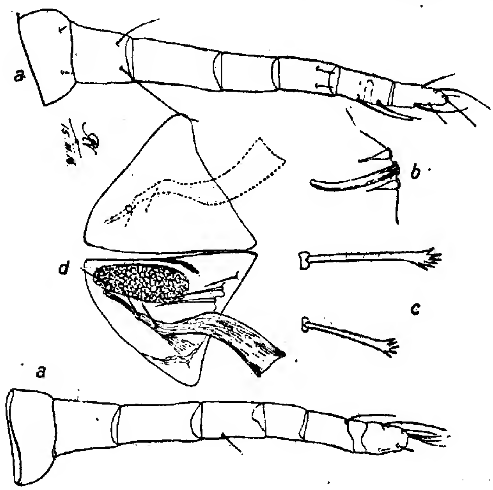


Fig. 12. *Lecanium cajani*, Newst., sp. n., ♀; *a, a*, antennae; *b*, stigmatic spines; *c*, marginal spines; *d*, anal lobes.

resembling dried oil-colour, and is firmly attached to the integument.* The remaining portion of the dorsum is of a bright yellowish-buff; eyes and submarginal gland-pores black. Young adults are pale, translucent yellow. Young parasitised examples with the whole of the central area of the dorsum intense shining black. After treatment with KOH the integument is thin and transparent. Antennae (fig. 12, *a*) of seven segments; 6th and 7th with two long slender spinose hairs; formula (one example): 3, (2, 4, 5, 6, 7) 1. The antenna on the opposite side is slightly malformed.

* This may be an artifact produced by foreign matter.

Rostral filaments very short. Legs well developed and the tibio-tarsal articulations very clearly defined; coxae with three very long, distal hairs. Dorsal pores very small, somewhat circular and very widely separated. Stigmatic spines (fig. 12, *b*) three, the central one very long, broad and curved; the laterals somewhat bulbous at the base, attenuated and finely pointed; clefts shallow. Marginal spines (fig. 12, *c*) very long, being equal in length to the 4th segment of the antennae; they are dilated and frayed or divided at the tips. Anal lobes (fig. 12, *d*) with the base and outer edge about equal in length; inner margin longest; a very large spine attachment on the dorsal surface, well within the distal angle; ventrally (fig. 12, *d*) there is a narrowly elongated patch of chitin which presents a finely reticulated pattern; spines and sclerite as shown in the illustration; the relative position of these may, however, vary according to the pressure of the covering glass. Anal cleft four times as long as the anal lobes.

Length, 4·2 mm.; width, 2·2 mm.

S. NIGERIA: on pigeon-pea, 19.xii.13 (*Dr. W. A. Lamborn*).

The description of the old adult female is based upon a single example. One young adult and several second stage females were also collected by Dr. Lamborn, but all of these had been attacked by Chalcidids.

This insect belongs to the *L. longulum* group, but seems to be quite distinct and hitherto undescribed.

Lecanium hesperidum (Linn,) (Plate vi, figs. 1–6).

The colony from which I secured examples of the male puparia of this species, described by me* in the year 1902, was subsequently kept under observation until November 1904, when I was fortunate in securing perfect males—the first authentic examples obtained in any country, so far as I can trace, since Bouché's discovery in or about the year 1867. As his description, quoted by both Boisduval† and Signoret‡ under the synonym *L. lauri*, Boisd., is of the vaguest possible kind, I give the following details and append figures of this cosmopolitan pest which I trust may prove of interest.

Male (Pl. vi, fig. 1.). Wings ample and faintly iridescent; costal nervure bright rose-pink. Body dull crimson or bright pale castaneous; thoracic plates and apodeme slightly darker. Legs and antennae paler than the body; hairs glistening white; eyes and ocelli black. Antennae (Pl. vi, fig. 2) very hairy, of ten segments; 4th and 7th longest; apical segment with five long and faintly clubbed hairs. Upper surface of head and genae hairy. Legs hairy; digitules normal. Abdomen hairy ventrally; anal segment (Pl. vi, fig. 3, 3 *a*) with a pair of long white filaments, a pair of relatively long slender hairy tubercles and also a pair of large protruding gland-like processes. Each of the white filaments is supported by a pair of bristles one long the other relatively short. Stylus (Pl. vi, fig. 3) somewhat bluntly pointed.

Length, 1·75 mm.

Male puparium (Pl. vi, fig. 4). This has already been described (*l.c.*).

* Coccidae Brit. Isles, ii. p. 83.
† Essai. p. 230 (1873).
‡ Ent. Hort. p. 340 (1867).

Male, second stage (Pl. vi, fig. 5). Very elongate, translucent ochraceous-yellow, margins darker or yellowish green, dorsal ridge rich dark brown; anal lobes varying from pale yellow to pale red.

Male larva. Resembling that of the female but more elongate. Pale translucent yellowish-green; dorsal area ochraceous. Eyes black.

Pupa (Pl. vi, fig. 6). At first pale reddish-ochreous, later bright reddish-ochraceous. Thorax darkening with age. Eyes purple-brown or dark red-brown.

ENGLAND: Bournemouth and Chester, on a date palm (*Phoenix dactylifera*), 25.xi.1904 (*R. Newstead*).

Lecanium (Saissetia) hurae, sp. nov.

Female, adult. Dried examples very irregular in shape, but the general outline is somewhat hemispherical; integument coarsely folded and indented; margin coarsely punctate; surface glabrous. Colour pale dull brown to dull castaneous, with irregular black spots, which are generally more numerous at the sides, more

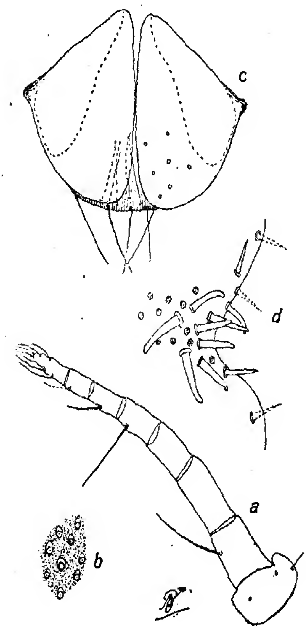


Fig. 13. *Lecanium hurae*, Newst., sp. n., ♀; *a*, antenna; *b*, derm glands; *c*, anal lobes; *d*, stigmatic cleft.

especially so in very old examples. After maceration in KOH the outline of the body is very broadly ovate with the ends almost equally rounded. Antennae (fig. 13, *a*) of eight segments, with a very long hair on the 3rd and 5th and a long slender spine

on the 6th and 7th; terminal hairs short and stout. Legs strong, normal; tarsus of 1st pair nearly as long as the tibia; two hairs on the trochanter. Stigmatic clefts faintly indicated; spines in a compact dense group consisting of from ten to twelve, all of them much stouter and longer than the marginal spines, the innermost ones largest of all and flattened. Marginal spines simple, short and pointed, very widely separated, excepting at the distal margin, where five to six are placed much more closely together; within the margin is a series of smaller spines, somewhat irregularly disposed; the chitinous disks upon which these hairs are seated are as large as the marginal ones; similar minute spines are thinly scattered over the whole of the dorsum. Derm cells (fig. 13, *b*) very minute, with a central pore, and in old, well stained examples these give the integument a speckled appearance; they are most numerous in the region of the anal lobes; in younger examples these appear as minute pores. Anal lobes (fig. 13, *c*) thick, obtuse and broadly rounded distally; dorsal surface with several widely separated hairs. Anal cleft very short. Anal ring with ten hairs; retractile tube with not less than eight hairs; ten or more may be present.

Length, 3·5–5·1 mm.; height, 2·1–3·2 mm. (dried examples).

Female, second stage. Much more elongate than the adult. Integument, when dry, deeply wrinkled; colour dusky buff, generally with conspicuous black spots. Antennae of seven segments. First pair of legs scarcely longer than the antennae; tarsi with a clearly defined constriction dorsally. Marginal spines as in adult. Stigmatic cleft (fig. 13, *d*) small; spines very like those in the adult, but seem to be fewer in number and not so closely packed together. Anal lobes not differing markedly from those of the adult.

Larva. Stigmatic spine long, stout and curved, marginal hairs simple and nearly as long as the corresponding spines in the adult female. Hair of the anal lobes about equal in length to the legs.

British Guiana: Berbice, on *Hura crepitans*, 27.xi.13 (*G. E. Bodkin*).

Lecanium (Saissetia) persimile, sp. nov.

Female, adult. Not differing appreciably in its external form, colour, and density of chitin from *Lecanium* (*Saissetia*) *oleae* (Bernard), but in two examples the dorsum was covered with a fine dusky-white, mealy secretion. The median longitudinal and two transverse ridges, forming roughly the letter **H**, well marked in two specimens, but absent in another. Anal cleft completely fused. Anal lobes attenuated, outer angle broadly rounded, inner edge much the longest; apex bluntly pointed, with one or two short spines. No stigmatic clefts; spines three, the central one slightly more than twice the length of the laterals. Antennae well developed, of eight segments. Legs rather slender; lower digitules very robust, incrassate proximally, dilated distally. Derm thickly studded with small, but well-defined, oval and translucent cells; these are much more crowded together at the marginal and also larger.

British East Africa: Nairobi, on peach stems, i.1914 (*T. J. Anderson*).

The one salient character by which this Coccid can be distinguished from *Lecanium* (*Saissetia*) *oleae*, (Bern.) is the non-reticulated appearance of the derm. In all

other respects, so far at least as I am able to judge by the scanty material at hand, the two insects are practically identical. But the derm cells in *oleae* are so strikingly different that I have no hesitation in erecting a new name for Mr. Anderson's specimens. *Lecanium (Saissetia) sylvestrii*, Leonardi,* bears some resemblance to *persimile*, but is clearly distinct.

Lecanium (Saissetia) subhemisphaericum, sp. nov.

Female, adult. Not differing from *Lecanium hemisphaericum*, Targ., in its general form and colour. Dermal pores mores or less circular, exceedingly few in number,† irregularly scattered and extending almost to the margin; the latter with short, closely set pigment bands. Stigmatic clefts minute; spines three, the laterals short and stout; middle one also very stout and rather suddenly pointed. Marginal spines all broken away. Anal cleft united. Anal lobes more or less triangular, inner edge slightly the longest. Antennae (fig. 14) of seven segments, the 3rd, 4th and 7th much the longest; the last three each with a long spine, that on the terminal segment being markedly the stoutest; formula: 3, 7, 4, 2, 1 (5, 6), or (3, 7) 4, 2, 1, (5, 6). Legs slender but well developed; lower digitules stout.

Length, 1·9–2·9 mm.

UGANDA: Naguriga, Chagwe, on coffee, 27.ii.13 (*C. C. Gowdey*). GOLD COAST: Aburi, on coffee, 27.xii.15 (*W. H. Patterson*).

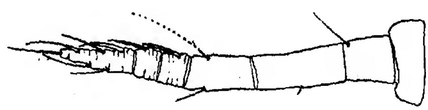


Fig. 14. *Lecanium subhemisphaericum*, Newst., sp. n.; antenna of ♀.

The affinities of this species are somewhat doubtful, but judging by the dermal characters alone, it fits best in the sub-genus *Coccus* in Fernald's classification. But as it bears such a close resemblance to *Lecanium (Saissetia) hemisphaericum*, I feel that it is best placed in this section for the time being. Easily determined by the somewhat unusual form of the antennae and the sparsity of the derm glands.

Lecanium (Saissetia) signatum, sp. nov.

Female, adult. Broadly ovate, sometimes attenuated in front; flat and finely rugose, but slightly glossy. Dorsum generally with a well marked ⊥-shaped ridge, the transverse bar of which is longer than the stem. Colour varying from pale castaneous to dark piceous; the pale forms sometimes with a relatively broad dark marginal zone, the dark forms often with a paler margin. Antennae (fig. 15, *a*) of seven segments, of which the 4th is the longest; but this segment often has a partial, or in some instances even a complete, subdivision just below the distal constriction; 7th segment somewhat variable in length, but usually much longer than the preceeding one. Legs with the tibio-tarsal articulation (fig. 15, *g*) more or

* Bull. Lab. Zool. Gen. Agr. Portici, v, p. 276, fig. xxii (1911).

† In the field of a Leitz 7th objective (No. 4. eyepiece) the following counts were made in eight different parts of the derm: 3, 0, 0, 0, 1, 0, 4, 6.

less central; digitules long, the lower pair robust. Anal cleft fused and three times as long as the anal lobes; the latter (fig. 15, *b*) somewhat pointed, the outer edge much longer than the base. Stigmatic clefts obsolete; spines (fig. 15, *c*) three, the laterals very short and faintly bulbous. Marginal spines (fig. 15, *d*) small; some are slightly dilated and irregularly divided distally; others, especially in the cephalic and anal regions, are more or less palmate (fig. 15, *e*, *f*). Derm with a pronounced tessellation of irregularly polygonal cells, the central spots varying in size from a minute speck to a large oval one nearly filling the cell area.

Length, 3·5–4·5 mm.; width, 2·5–3·4 mm.

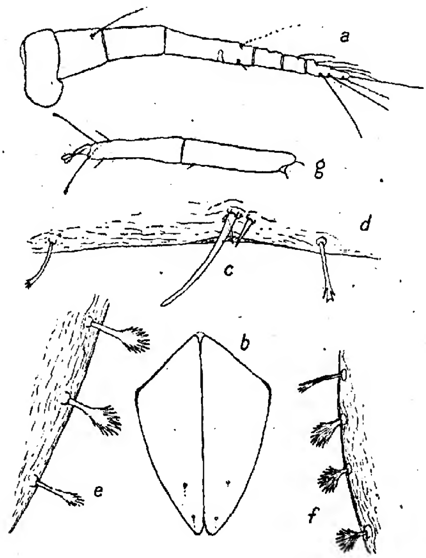


Fig. 15. *Lecanium signatum*, Newst., sp. n., ♀; *a*, antenna; *b*, anal lobes; *c*, *d*, stigmatic and marginal spines; *e*, *f*, other forms of marginal spines; *g*, leg.

Female, second stage. Elongate and flat. Colour translucent yellow to dull buff. Parasitised examples with a central elongated, polished, black swelling. Structural details similar to those of the adult, but many of the marginal spines (fig. 15, *f*) are markedly palmate.

UGANDA: Entebbe, on guava, 4.iii.14 (*C. C. Gowdey*).

Very like the flat forms of *Lecanium* (*Saissetia*) *nigrum* (Nietn). But the ⊥-shaped ridge, the form of the antennae and the marginal spines are dissimilar and distinct.

Lecanium (Saissetia) scutatum, sp. nov.

Female, adult. Generally more or less hemispherical; shining, rich, dark castaneous, often with obscure darker markings; small detached particles of glassy

secretion sometimes present in examples under cover of the ants "tents." When overcrowded the form is irregular, and the anal lobes are so arranged that they appear to be placed near the middle of the back, as in *Stictococcus*, but this is largely an artifact produced by the tilting of the posterior margin or by the pressure of an adjacent female. *Antennae* (fig. 16, *a*) and legs sub-rudimentary; the former not quite so long as the anal lobes, composed of six segments, the articulations being very clearly defined. Anal cleft partly fused. Anal lobes (fig. 16, *b*) very thick, rounded, and somewhat crescentic in outline, the pair together resembling the stumpy "jaws"

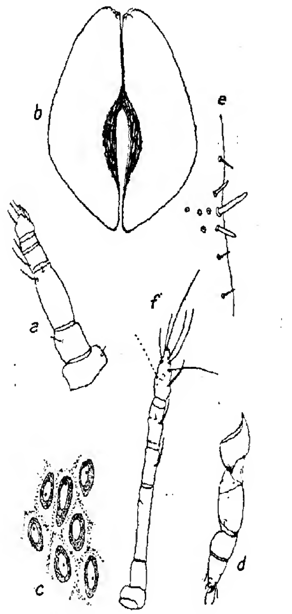


Fig. 16. *Lecanium scutatum*, Newst., sp. n., ♀; *a*, antenna; *b*, anal lobes; *c*, gland pores; *d*, leg; *e*, stigmatic and marginal spines; *f*, antenna of larva.

of a pincers. Derm densely chitinised, and crowded with cells (fig. 16, *c*), which are irregularly ovate or elliptical, having a more or less concentric ring of darker chitin and a central, subcentral or submarginal pore. Between the cells, in places, is a faint line which, when well defined, gives a polygonal reticulation.

Length, averaging 2·4 mm.

Female, second stage. Covered with a thin, vesicular and opaque glassy test, which is easily deciduous. Form short, ovate, flat; dorsum with a median ridge, from which radiate irregular rugose ridges. Antennae and legs as in the adult, the legs (fig. 16, *d*) of about the same length as the antennae, all the segments clearly defined; tarsus

either equal to or a little longer than the tibia. Marginal spines (fig. 16, *e*) minute, slender and hair-like; stigmatic clefts scarcely indicated; their spines (fig. 16, *e*) three, small; the central spine about twice the length of the laterals. Anal cleft not fused, about one-fourth the length of the body. Anal lobes similar to those of the adult.

Length, 1·3–1·5 mm.

Larva. Normal in shape. Antennae (fig. 16, *f*) slender, about one and a half times as long again as those of the adult and second stage female; terminal segment incrassate and with the apical hair nearly half the length of the antenna; 4th, 5th and 6th with a slender spine. Marginal and stigmatic spines similar to those in the succeeding stage. Rostral filaments nearly three times the length of the body. Apical setae on the anal lobes about the same length as the body.

Male puparium. Elongate ovate, glassy, white, and vesicular, but *not divided into plates* as is usual in the genus.

Length, 1·3 mm.; width, 0·8 mm.

British Guiana: Botanic Gardens, Georgetown, on "Cannon Ball Tree" (*Mimusops globosa*), 12.iii.14 (*G. E. Bodkin*).

"The colonies of the female Coccids were attended by a small black ant which had constructed the rough covering over them" (G. E. B.).

Lecanium (Saissetia) subpatelliforme, sp. nov.

Female, adult. Varying from broadly to narrowly ovate, centre generally highly gibbose; surface rather roughened or slightly rugose, often with widely separated patches of secretion, especially at the sides; dorsum (gibbosity) often shining. Derm

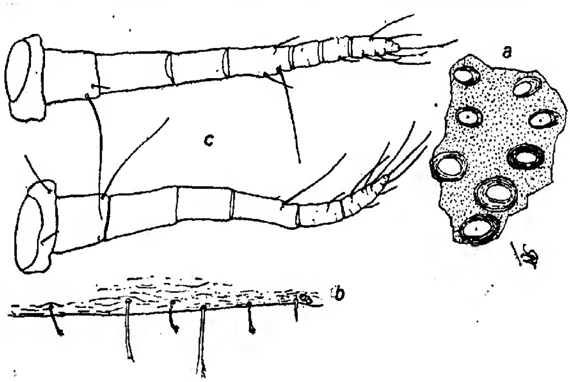


Fig. 17. *Lecanium subpatelliforme*, Newst., sp. n., ♀: *a*, derm cells; *b*, marginal spines; *c*, antennae.

cells (fig. 17, *a*) of the median and sub-median areas small, ovate and widely separated, those near the margin much larger. Marginal spines (fig. 17, *b*) of two kinds: (1) long and rather stout, dilated and divided on both sides; (2) similar spines, but only about half the length of the long ones. Stigmatic clefts practically obsolete; spines

three, the laterals small, stout and pointed; central one missing in all the preparations. Eyes well defined. Antennae (fig. 17, c) of seven or eight segments (both forms present in one ♀). Legs well developed; tarsus almost equal in length to the tibia; lower digitules stout, upper pair normal. Anal lobes with the base and outer edge of equal length, approximately. Anal ring of eight hairs. Anal cleft varying in length from a little less than a third to one-third the length of the body.

Length, 3·8–5·2 mm.

GOLD COAST: Aburi, food-plant not stated (*W. H. Patterson*).

Young females are flattish and very like large examples of *L. nigrum*.

Lecanium (Saissetia) subhirsutum, sp. n.

Female, adult. Form on slender branches very elongate, highly convex and narrowed anteriorly, on thick branches (rare) broadly ovate and less convex; anal cleft forming a more or less distinct keel; lobes prominent and *seated in a well marked depression.* Integument "matted," with the dorsum often slightly polished or

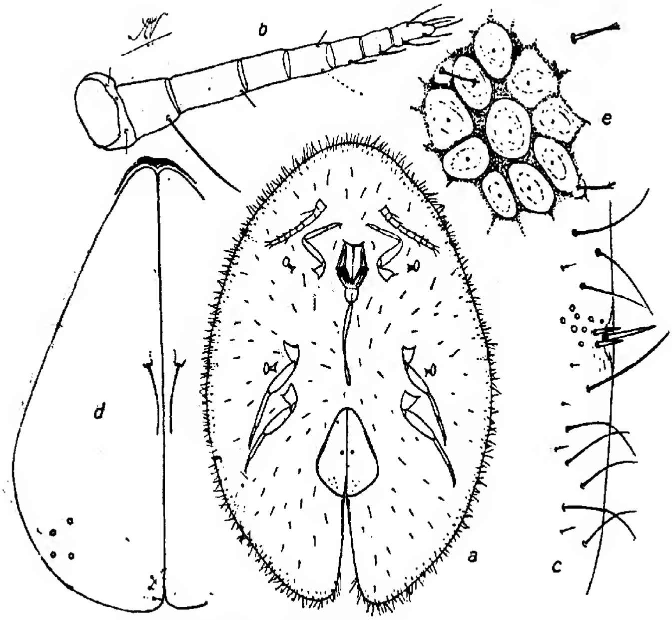


Fig. 18. *Lecanium subhirsutum*, Newst., sp. n., ♀; *a*, adult as seen in optical section; *b*, antenna; *c*, marginal and stigmatic spines; *d*, anal lobes; *e*, derm cells and spines.

entirely glabrous and shining. Colour generally dark castaneous, with minute, pale, obscure freckles, which are often more conspicuous in the marginal areas. Immature examples are dusky ochraceous with obscure blackish markings; on drying, these generally lose their form and become shrivelled or wrinkled. After maceration in

KOH the general outline of the insect is approximately ovate (fig. 18, *a*) but almost invariably asymmetrical. Antennae (fig. 18, *b*) of eight segments, rarely of seven; in the former there is a very long hair on the 2nd, and the terminal hairs on the 8th are all very short; 3rd segment sometimes with a very faint sub-division. Legs well developed and somewhat robust; tarsal digitules stout and faintly knobbed; lower digitules markedly incrassate proximally, distally very broadly spathuliform. Stigmatic clefts obsolete; stigmatic spines (fig. 18, *c*) three, stout and pointed, central one generally more than twice the length of the laterals, but in some instances one of the latter may be nearly as long as the median. Marginal spines (fig. 18, *c*) reduced to long, fine, flagellate hairs; these are arranged in an irregular series two or three deep, and immediately within them an irregular row of small hairs. The anal cleft appears slightly fused in some examples, but it generally separates quite readily. Anal lobes (fig. 18, *d*) subcentral and exceptionally large; length equal to that of antennae; base bluntly pointed, apex very broadly rounded, so that together they are broadly pyriform in outline; a long stout hair is present near the centre of the inner margin; there is also a group of from four to six much smaller hairs towards the outer rounded portion, and two to three minute ones near the inner angles. Anal ring of (?) eight hairs; there is a bilateral group of four long hairs on the retractile tube, and a similar pair of hairs near to the somewhat ill-defined chitinous sclerite. Derm (fig. 18, *e*) sparsely hirsute (*some of the hairs having divided tips*) and packed with well-defined but somewhat irregular translucent cells, the majority of which are roughly oval in shape, the dividing lines between them presenting a polygonal tessellation.

Length, 2·3–2·3 mm.; width, 1·8–2·5 mm.

Female, young adult. Differs from the old adult ♀ only in having the derm cells less pronounced.

Larva. Margin with a series of long stout hairs, which are widely separated, excepting those on the frons, which are placed much more closely together. Stigmatic spines three, the laterals exceedingly minute, the central one of great length, being slightly longer than the marginal hairs.

Gold Coast: Odumasi, on *Blighia sapida*, iii, 1906; "very abundant, especially on the smaller branches. Attended freely by small red ants" (*Dr. Slater Jackson*); Aburi, on *Tabernaemontana*, *Landolphia*, *Oroxylon* and *Garcinia* (*W. H. Patterson*).

The colony on *Tabernaemontana* is remarkable for the highly polished surface of the integument; this characteristic is present also in a few of the individuals collected from the other food-plants both by Jackson and Patterson respectively, but to a much less marked degree. The glandular character of the derm, the large size of the anal lobes and the deep transverse depression in the dorsum, apart from the setose character of the derm, are the salient characteristics of this Coccid. It is near *L. catori*, Green (Bull. Ent. Res., vi., p. 43), but differs from this species by the hirsute character of the derm, the larger number and irregular arrangement of the marginal hairs, and also in having a free abdominal cleft; in *L. catori* the last-named is fused.

Lecanium setigerum, sp. nov.

Female, adult. Short ovate and flat; generally slightly narrowed in front, rarely more or less deltoid. Bright buff to smoky brown in colour when dried. Antennae (fig. 19, *a*) of seven segments; 3rd very slightly longer than the 4th, the latter with a

large clear space in the chitin, in the region of the long outstanding hair; all the articulations broad. Legs normal. Anal lobes (fig. 19, *b*) conjointly pyriform in outline, narrowest proximally. Anal cleft twice the length of the lobes. Derm glands (fig. 19, *c*) relatively large, irregularly and narrowly ovate. Marginal spines (fig. 19, *d*) more or less alternately very long and short, all divided distally and a few somewhat palmate; the longest are of exceptional length and markedly conspicuous. At the angles of the anal cleft are three to four, usually three, very long bristles, the longest of which is equal in length to the anal cleft. Stigmatic clefts obsolete; spines three, the central one exceptionally long.

Length, 1·5–2·2 mm.

Female, second stage. Antennae of six segments, the 3rd the longest. Stigmatic clefts and spines as in the adult; marginal spines also similar, but much more widely separated.

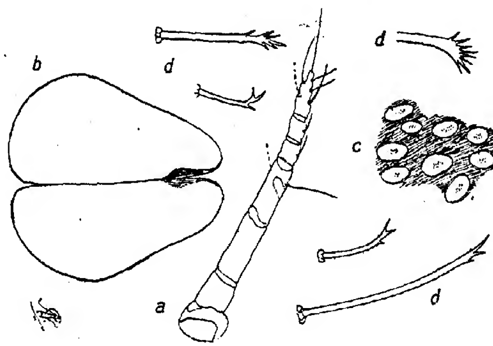


Fig. 19. *Lecanium setigerum*, Newst., sp. n., ♀; *a*, antenna; *b*, anal lobes; *d, d, d*, marginal spines.

UGANDA: Nagunga, on guava, 18.ix.15 (*C. C. Gowdey*).

A very small species, belonging apparently to the *hesperidum* group, but markedly distinct and easily determined by the group of bristles at the angles of the anal cleft, the relatively large marginal spines and the form of the anal lobes. Some of the females contained embryo larvae.

Lecanium (Eucalymnatus) chelonioides, sp. nov.

Female, adult. Form flat; very broadly ovate or narrowly so, and more or less asymmetrical. Completely covered with a thin, glassy test, which is divided into distinct, easily separable plates, corresponding exactly with the plates in the integument of the dorsum (fig. 20, *a*); margin of each plate with a strongly defined, narrow ridge; the flat interior generally with very faint radial and concentric striae. Colour of dried specimens varying from pale to rich dark castaneous, margins paler. Young adults are dusky amber brown. Dorsum, after maceration in KOH, divided into large plates (fig. 20, *a*) forming a more or less regular marqueterie pattern; there are three rows of these plates on either side of the median line, but the divisional sutures between

the 2nd and 3rd or marginal series are partly incomplete and replaced by a series of pores. Cephalic plate large and *not divided medially*; pores exceedingly minute and very widely separated; a few only on each plate. A submarginal tubercle is present in nearly all of the sutures. Antennae (fig. 20, *b*) of seven segments, of which the 3rd is slightly the longest; the 4th–7th, inclusive, exceptionally long and varying but slightly in their relative lengths. Stigmatic clefts (fig. 20, *c*) small, narrow, but clearly defined; spines three to four (usually three), very short and stout, with bluntly rounded tips. Marginal spines (fig. 20, *c*) almost invariably broken away, but the few which remained in the preparations are exceedingly minute. Anal lobes (fig. 20, *d*) obtusely rounded distally.

Length, 5–6·5 mm.

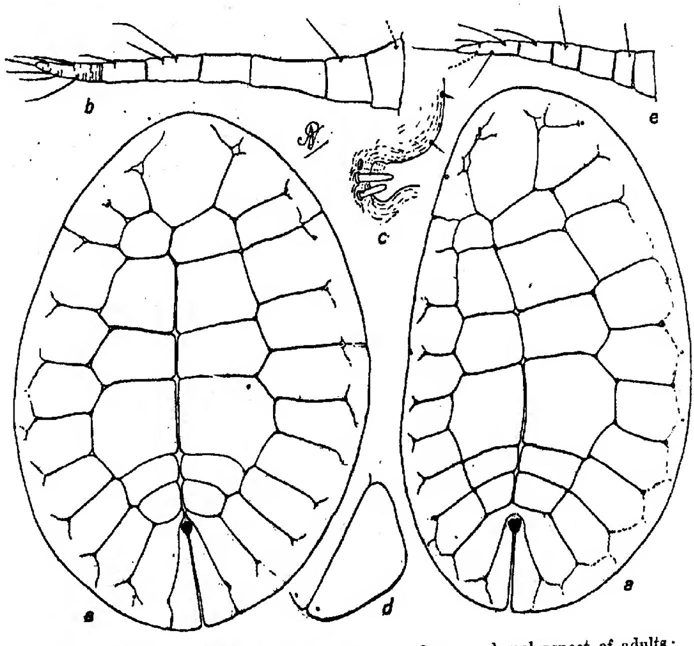


Fig. 20. *Lecanium chelonioides*, Newst., sp. n., ♀; *a*, *a*, dorsal aspect of adults; *b*, antenna; *c*, stigmatic cleft; *d*, anal lobe; *e*, antenna of second stage ♀.

Female, second stage. Very elongate; cephalic margin slightly broader than the posterior margin. Antennae (fig. 20, *e*) of six segments, the 6th much the longest. Legs rather short, first pair about equal in length to the antennae. Stigmatic spines three in number, and very like those in the adult ♀, but relatively smaller, and the laterals slightly curved. Marginal spines exceedingly minute, simple.

Male puparium. Thin, glassy and transparent; surface finely rugose and divided into eight plates; central plates unusually narrow. Length, 3 mm.

British Guiana: Botanic Gardens, Georgetown, on *Pachira insignis*, 12.ii.14; Essequibo River, near Agatask, on *Pachira aquatica*, 11.v.13 (*G. E. Bodkin*).

A very interesting and strikingly characteristic species. Closely related to *L. brunfelsia*, Hempel,* and *L. gracile*, Hempel,† but distinguishable from both by the presence of a well formed test, the arrangement of the dorsal plates and the antennal formulae.

Aspidiotus camelliae, Sign.

Puparium of female. Larval pellicle blackish or piceous; second pellicle rich brown to piceous. Secretionary portion of puparium with a free admixture of fibres from the food-plant. Form as in typical examples. Margin of pygidium (fig. 21, *a*, *b*) with the squamae, especially those beyond the third pair of lobes, varying in a marked degree in different individuals and presenting a distorted or malformed appearance;

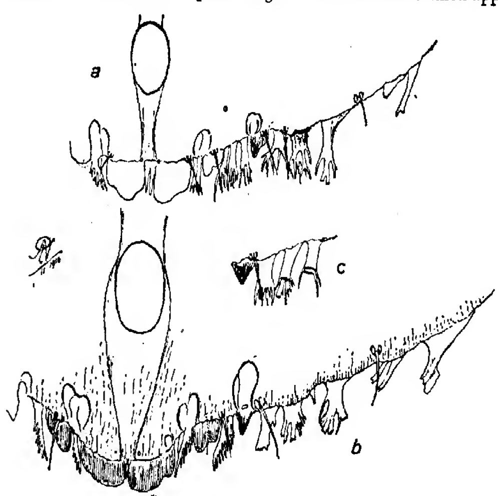


Fig. 21. *Aspidiotus ? camelliae*, Sign., ♀; *a*, *b*, malformed fringe of pygidium; *c*, curiously truncated squamae.

in two instances the structures were truncate (fig. 21, *c*) just above the origin of the lateral processes, with a single or double ring of chitin at the extremity. In other respects the females appear to be quite normal.

The inconstancy of form and strikingly malformed appearance of the squamae is, I think, due to disease, but certainly not to either fungi or insects, as no trace of such parasites were found.

British Guiana: Turkeyn, on *Erythraspis glauca*, 17.ix.15 (*G. E. Bodkin*).

Aspidiotus (Chrysomphalus) dictyospermi, Morgan.

Uganda: Entebbe, on rose-shrubs, 20.ii.13 (*C. C. Gowdey*).

The branches submitted were heavily infested by this Coccid; and about 80 per cent. of the colony had been destroyed by a fungus. The parasitised examples had

* Revista do Museu Paulista, iv, p. 418, pl. vii, figs. 15, 16.
† Ibid, p. 419, pl. vii, fig. 1.

greyish and very brittle puparia, such examples agreeing very closely with Morgan's description.* The healthy females had pale orange-brown puparia and were much tougher than those which were parasitised; these, though paler, are clearly referable to the var. *arecae*, Newst. In the light of this discovery one feels that Morgan's examples may also have been parasitised, and if this were so, my var. *arecae* must sink. It may be interesting to add that the parasitised puparia show no external signs of the fungus apart from the colour, and when examined microscopically little trace of hyphae could be found; on the other hand the females showed a very heavy infestation.

Aspidiotus (Chrysomphalus) erythraspidis, sp. nov.

Female puparium. More or less circular or irregularly ovate, moderately convex, surface more or less roughened by the fibres of the plant upon which it was fixed. Pale brownish buff or greyish buff, sometimes with slightly darker lines of growth.

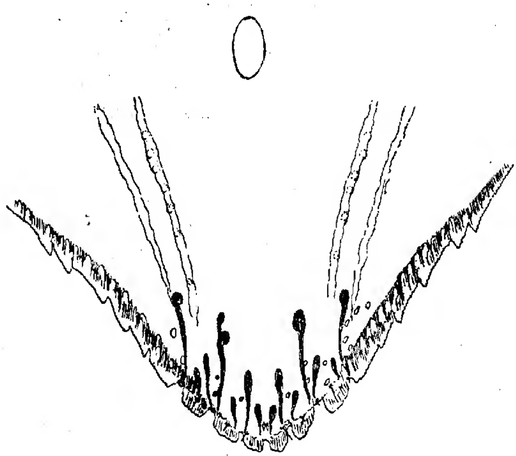


Fig. 22. *Aspidiotus erythraspidis*, Newst., sp. n.; pygidium of ♀.

Underside blackish, margin similar in colour to the exterior. Pellicles central, subcentral or submarginal, black; the secretionary covering greyish, but usually absent from the larval pellicle. Greatest diameter, 1·7–2·1 mm.

Male puparium. Dark brown or brownish black, margin paler; larval pellicle black, with a narrow, but sharply defined, concentric ring of white secretion. Shape normal.

Female, adult. Pyriform, with the pygidium strongly produced and somewhat pointed; thoracic area with a very faint tubercular projection, which almost entirely disappears under pressure. Rudimentary antennae with three spines; one very

* Ent. Mo. Mag., xxv, p. 352, pl. v, fig. 2 (1889).

long and curved, the others exceedingly minute. Parastigmatic glands absent. Circumgenital glands in four groups; formulae of five examples :—

$$\frac{9\quad 8}{5\quad 4}\qquad \frac{7\quad 6}{4\quad 4}\qquad \frac{8\quad 7}{4\quad 4}\qquad \frac{8\quad 7}{4\quad 4}\qquad \frac{8\quad 6}{3\quad 4}$$

In one instance the fifth group is represented by a single gland. Anal orifice immediately below the posterior-lateral groups of circumgenital glands. Above the the grouped glands a narrow transverse thickening of the derm, which may be entire or divided into three parts :. a median and two lateral. Margin of pygidium (fig. 22) with three pairs of lobes, all of which are relatively broad; the third pair the largest; distal margins irregularly and faintly dentate or serrate. Beyond the lobes the margin is thickened and projecting, with minute serrations and, usually, six deep indentations. In some examples the lobes and serrated projections of the margin are so continuous that it is somewhat difficult to determine where the one begins and the other ends. The ducts which lead to the spaces between the lobes are fourteen in number, of which four are much longer than the rest; each with a distinct knob-like terminal. Squamae, when present, exceedingly minute; these were traced with difficulty, between the lobes, in a few instances only.

BRITISH GUIANA: Turkeyn, on *Erythraspis glauca*, 17.ix.15 (*G. E. Bodkin*).

Nearly allied to *A. scutiformis*, Ckll., and *A. kelloggii*, Ku., but differs in the form and arrangement of the pygidial appendages, the club-shaped ducts, and the circumgenital glands.

Aspidiotus (Evaspidiotus) fimbriatus, Mask., var. **capensis**, var. n.

Female, adult. Differing from typical *Aspidiotus fimbriatus* in having much more deeply fringed squamae to the margin of the pygidium (fig. 23, *a*) and fewer

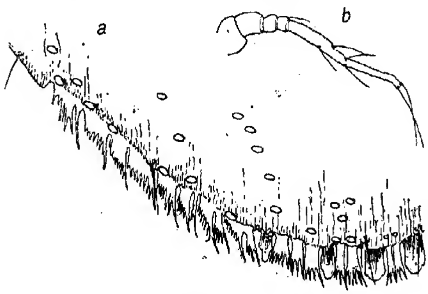


Fig. 23. *Aspidiotus fimbriatus* var. *capensis*, Newst., nov.; *a*, fringe of pygidium of ♀; *b*, antenna of larva.

circumgenital glands; the latter are also often arranged in five groups instead of four. The following are the formulae of five examples :—

$$\frac{\overset{0}{8\quad 8}}{5\quad 5}\qquad \frac{\overset{2}{6\quad 8}}{5\quad 4}\qquad \frac{\overset{0}{5\quad 5}}{6\quad 6}\qquad \frac{\overset{3}{8\quad 4}}{4\quad 5}\qquad \frac{\overset{2}{4\quad 8}}{5\quad 5}$$

Larva. Antennae (fig. 23, *b*) of five segments, last segment nearly as long again as the rest and finely ringed.

SOUTH AFRICA: Port Elizabeth, on Cycads, 1914 (*de Charmoy*).

Aspidiotus (? Chrysomphalus) mauritianus, sp. nov.

Female puparium (fig. 24, *a*). Subcircular; anterior extremity very slightly produced; posterior extremity strongly uptilted by the ventral pellicle, which is markedly thickened and tongue-shaped, but does not project beyond the dorsal pellicle; the thickened portion rests upon a thinner pellicle of secretionary matter, so that when examined in profile the puparium resembles the partly open bivalve shell of a mollusc with the "foot" showing between the valves. Larval pellicle subcentral, very prominent, and somewhat hemispherical. Colour bright yellowish-buff or reddish-buff, with generally distinct concentric bands of a darker colour.

Length, 0·8–1 mm.

Female, adult (fig. 24, *b*). Broadly pyriform; free abdominal segments tuberculate at the margins, the tubercles finely but sparsely setose and glandular. Frons sparsely spinose. Rudimentary antennae with *five hairs*, two of which are much thicker and longer than the rest and also strongly curved over the tips of the short

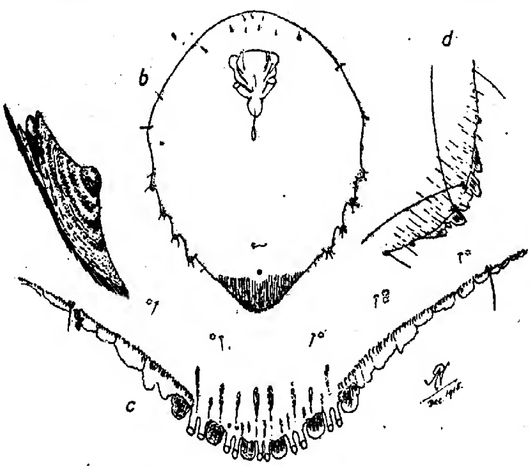


Fig. 24. *Aspidiotus mauritianus*, Newst., sp. n., ♀; *a*, puparium; *b*, adult; *c*, fringe of pygidium; *d*, pygidium of larva.

hairs. Anterior stigmata with five to six glands, arranged in line, the innermost one considerably beyond the proximal end of the stigmata. Pygidium sparsely spinose; lower portion strongly chitinised, and finely striated vertically; fringe (fig. 24, *c*) with three pairs of well developed lobes; between each lobe a pair of tubular-shaped squamae, the tips, in well stained specimens, appearing as if obliquely truncated; margin beyond the third lobe with thin, irregular, dentate plates. Anal orifice just above the chitinous portion. No circumgenital glands.

Length, 0·5–0·65 mm.

Male puparium. Larger than that of the female and strongly produced posteriorly; pellicle subcentral and very prominent; colour as in that of the female, but with no zonal bands.

Length, 1–1·1 mm.

Male, second instar. Elongate, markedly attenuated posteriorly. Pygidium narrowed distally; lobes and tubular squamae as in the adult female.

Male, third instar. Completely enclosed within the pellicle of the second instar, and filling it with the exception of the pygidial area. Short, stumpy antennal and leg-sheaths present. Anal segment of abdomen lobed, each lobe with a pair of stiff stout hairs, one of which is as long again as the other; the two succeeding segments have also a pair of short stiff hairs.

Male. Winged. Legs strongly spinose. Two pairs of large ocelli.

Larva. Short ovate. Antennae of six segments; terminal segment as long as the three preceding ones, with a long slender lateral spine; formula: 6, 1 (2, 3, 4, 5). Between the antennae, dorsally, are two pairs of very long hairs, the longest pair *two-thirds the length of the body*; behind these are four much shorter hairs; marginal hairs in pairs, one about one-third the width of the body, the other much shorter. Pygidium (fig. 24, *d*) with two pairs of lobes and a pair of long setae.

MAURITIUS: Botanic Gardens, on palm trees, 1915 (*de Charmoy*).

Chiefly on the upper surface of the leaves, in association with *Asterolecanium spectabile*, sp. nov., but the latter almost exclusively on the *under* surface of the leaf.

Green* has described a Coccid under the name *Aspidiotus* (*Chrysomphalus*) *cistuloides*, the female puparium of which is very like that of *mauritianus* in having the anal portion highly tilted. But the female of the latter species is entirely different and approaches very closely *Furcaspis rufa*, Lindinger,† in the structural characters of the fringe of the pygidium, both species possessing the singular truncated tubular squamae. *F. rufa* however possesses *three* of these structures between the second and third pairs of lobes, and also two additional pairs of long spinose hairs just beyond them. Moreover Lindinger makes no reference to the singular tilting upwards of the puparium in his species. I take it, therefore, that this marked characteristic was entirely wanting in his specimens. The larval characters of *A. mauritianus* differ from those of *F. rufa* only in the minute details of the pygidium.

Aspidiotus pimentae, sp. nov. (Plate vii).

Female puparium. Central pellicle resting in a well-defined circular pit or depression in the bark of the food-plant. Form subcircular, slightly produced posteriorly and uptilted by the thick ventral pellicle, which does not extend to the margin behind. Dorsal pellicle strongly convex or subconical; larval pellicle subcentral (in young forms it is central), more or less nipple-like, generally nude and bright castaneous or piceous; secretionary portion covered with the grey epidermal layer of the bark; beneath this the pellicle is thick and varies from dark castaneous to dark piceous. Ventral pellicle low convex externally, fitting closely into the pit or depression; central area with a thin, circular, whitish pellicle, the diameter of which is approximately equal to the width of the very dense dark border surrounding it. Greatest diameter averaging 1·5 mm.

Female, adult (fig. 25, *a*). *Without* thoracic constriction. Three or four of the abdominal segments well marked and slightly tuberculate at the margin. Rudimentary antennae with two long spines of equal length. Anterior parastigmatic glands

* Jour. Bombay Nat. Hist. Soc., xvi, p. 342.

† Jahrb. Hamburg Anst., xxx, Beih. 3, p. 39 (1913).

(fig. 25, *c*) three to eight in number, usually five to six. A few very long scattered hairs are present on the cephalo-thoracic and free abdominal segments; some well within the margin, others marginal; *small* circular pores occupy the same regions, and are much more numerous than the hairs, especially at the margins, but do not extend far beyond the region of the anterior stigmata. Pygidium *markedly but very finely striate longitudinally* over the whole area. Anal and vaginal orifice opposite and central. Pores minute, circular, extending over the whole area, but forming four bilateral linear bands; margin (fig. 25, *b*) with *seven* elongate paraphyses or rod-like thickenings of the body-wall; one central, arising from between the median lobes; the outer pair often faintly indicated in old, highly chitinised individuals. Lobes in

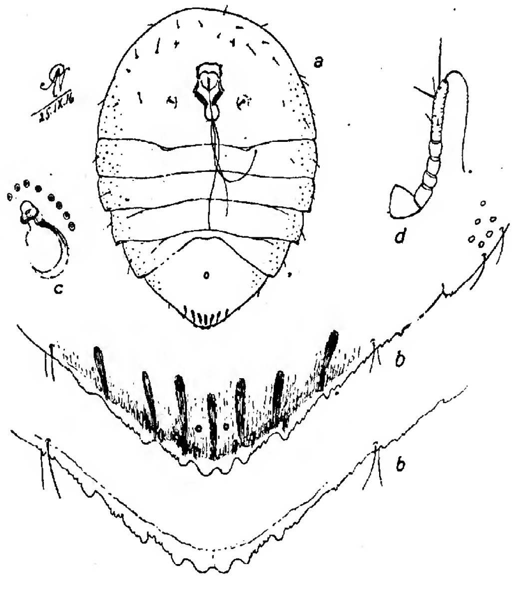


Fig. 25. *Aspidiotus pimentae*, Newst. sp n, ♀; *a*, ventral view of adult; *b*, *b*, margin of pygidium; *c*, parastigmatic glands; *d*, antenna of larva.

two pairs, the median pair the larger, but all are relatively small and in some individuals more or less rudimentary. Margin beyond the lobes with two or three dentate prominences, the intervening spaces finely dentate; three pairs of spinose curved hairs beyond the last dentate process, the middle pair much the smallest and often wanting.

Average length, 1 mm.

Larva. Antennae (fig. 25, *d*) of six segments, 1st much wider than the rest, 6th nearly equal in length to the 2nd, 3rd, 4th and 5th together, and furnished with three to four fine slender hairs; a subapical spinose hair and a very long apical one. Margin

of body with long stiff bristles. Pygidium with the usual caudal setae; median lobes relatively large and rounded distally; 2nd pair about half the length of the former, but twice the width and distinctly serrated.

JAMAICA: On *Pimenta officinalis* (*A. H. Ritchie*).

The following note was submitted with the specimens: "One property—Great Valley, in the Parish of Hanover—has lost upwards of 2,000 pimento trees and I can attribute no other cause than scale No. 504, which covers the trunks. It is travelling on this property in the direction of the prevailing winds and healthy trees are quite free, but trees showing scale gradually begin to die back from the tips of the branches. This scale is affected by a black fungus."

This species differs from *Aspidiotus bigeloviae*, Ckll.,* in the number, arrangement and size of the paraphyses to the pygidium, and markedly so in the form of the puparium. Very few members of the DIASPINAE have the puparium uptilted as in this insect, and the pit-making habit is even more restricted in this group.

Chionaspis distorta, sp. nov.

Female puparium. White, elongate, gibbose anteriorly, attenuated posteriorly; more or less straight, curved or contorted. Larval pellicle apical, dull red-brown, buff-yellow or sometimes dull crimson, margin generally paler; secretionary covering thin, white. Second pellicle large; colour intense rich orange-crimson, and generally

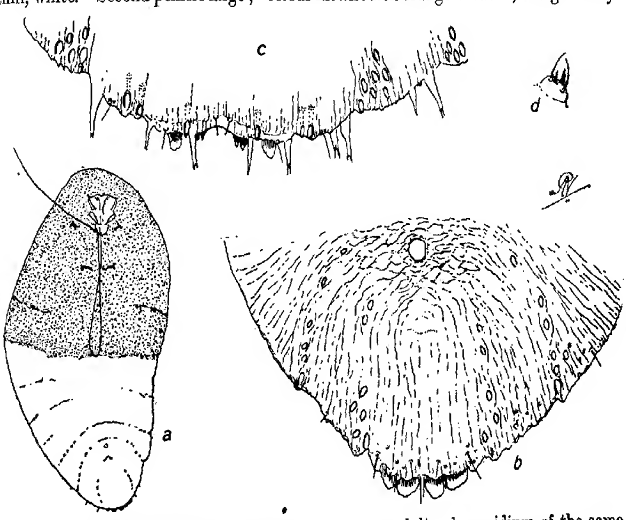


Fig. 26. *Chionaspis distorta*, Newst., sp. n., ♀; *a*, adult; *b*, pygidium of the same. *Chionaspis capensis*, Newst., sp. n., ♀; *c*, fringe of pygidium; *d*, antenna.

nude; secretionary covering, when present, thin, white. The secretionary portion of the puparium is often secreted in the small crevices of the bark so that it is almost completely hidden. Ventral scale rather dense under the anterior half of the female.

Length, 1 mm., average; greatest width, 0·4 mm.

* U.S. Dep. Agr. Div. Ent. Tech. Ser. No. 6., p. 20, fig. 12 (1897).

Female, adult (fig. 26, *a*). More or less elongate; cephalo-thoracic area highly convex, generally distorted, asymmetrical, and *highly chitinised*. Free abdominal segments and pygidium, constituting the lower half of the body, not highly chitinised; the line of demarcation between the non-chitinised and chitinised areas sharply defined. Proximal portion of rostrum very near to the cephalic margin. Rudimentary antennae midway between the rostrum and margin, each with a single spine. Stigmata large, anterior pair with four to five glands. Three free abdominal segments above the pygidium each with a few large glands and one or two minute spines. Pygidium (fig. 26, *b*) with strong convoluted striae in the region of the anal orifice, which lies just below the articulation. Margin thickened and somewhat irregular; median lobes moderately developed and very slightly divergent, the distal edge sometimes faintly but irregularly dentate; immediately adjacent to the lobes are two extensions of the body-wall and beyond them two prominent glandular extensions forming the terminals to the two short series of dorsal pores. Two minute spines between the lobes, one in each of the adjacent spaces, four within the margin, and one beyond the second series of dorsal glands. Two or three minute simple squamae are sometimes present between the series of dorsal glands.

Length, 0·7–0·75 mm.

South Africa: Windersboom, Transvaal, on an unnamed tree, 1915 (*de Charmoy*).

The highly chitinised anterior half of the body of the female and its remarkable distortions may readily serve to distinguish this species from its allies.

Chionaspis capensis, sp. nov.

Female puparium. Broadly pyriform and rather highly convex; opaque white, with a semi-glossy surface and a hard close texture. Pellicles terminal; colour dull orange-yellow with darker confused markings. Ventral scale well formed, but generally ruptured along the middle line.

Length, 1·5–2 mm.; width, 0·9–1·1 mm.

Female, adult. Very elongate, widest at the juncture of the thorax with the abdomen, narrowest in front. Rostrum well forward. Rudimentary antennae (fig. 26, *d*) close together immediately above the rostrum, with two long, slender, curved spines and two very stout spines, the latter a little less than half the length of the former; two or three fine hairs on the dorsum immediately above the antennae. First pair of stigmata very near the mentum, with nine to eleven glands; lower pair near the middle of the insect, with generally two glands; the glands in the former often form two to three sub-groups and collectively present a somewhat tessellated appearance. Dorsal tubular glands on the thoracic and first three abdominal segments small, with very short subcutaneous tubes; those on the remaining segments a little more than twice the size of the former and similar to those on the pygidium. Derm with fine convoluted striae. Pygidium (fig. 26, *c*) broadly rounded, with three groups of dorsal glands similar to those on the succeeding segments. Anal orifice close up to the articulation. Vaginal orifice a little in advance of the centre. No circumgenital glands. Fringe with two pairs of lobes; the median pair rudimentary, widely separated, duplex, and dentate; the second pair moderately developed and generally with a very faint notch towards the apex of the inner margin. Squamae

large, generally incrassate proximally and forked at the tips. There is one marginal tubular pore immediately in advance of the 1st squama, and two beyond the 2nd. Spines relatively short.

Male puparium. Non-carinated. Larval exuviae pale amber-yellow, cephalic region darker.

SOUTH AFRICA: Pretoria, on *Acacia* sp., 1914 (*de Charmoy*).

Chionaspis fici, sp. nov.

Female puparium. More or less mytiliform, highly convex. Colour creamy white, often rendered obscure by dirt or by the incorporation of the epidermal layer of the food-plant; in many individuals the incorporated material is arranged in more or less well defined conchoidal layers; larval pellicle dull orange; second pellicle similar in colour, but generally rendered obscure by a thick secretionary covering.

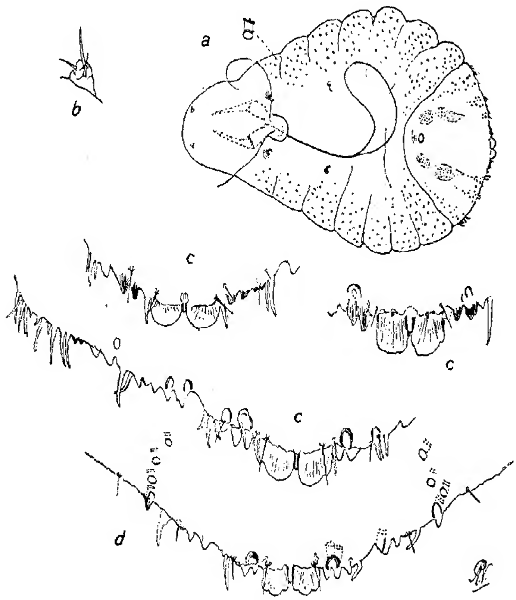


Fig. 27. *Chionaspis fici*, Newst., sp. n., ♀; *a*, adult; *b*, antenna; *c*, *c*, *c*, fringe of pygidium of adult; *d*, fringe of pygidium of second stage ♀.

Female, adult (fig. 27, *a*) generally broadly pyriform, after maceration in potash; widest in the mid-abdominal region; segmentation distinct; cephalic region much narrowed. Rudimentary antennae (fig. 27, *b*) with two to three spines, usually three. Stigmata relatively large; a large compact group of parastigmatic glands present at the anterior pair. Large tubular glands numerous and extending as far as the anterior pair of stigmata. Pygidium with five groups of circumgenital glands; in

the lateral groups the glands are exceptionally numerous: median group, two to eight; upper laterals, twenty-three to thirty-five; lower laterals, forty-two to sixty-five; margin of pygidium (fig. 27, *c*) with a single pair of median lobes, narrowly separated, relatively large, generally rounded distally, but sometimes with a lateral indentation; margin beyond distinctly and irregularly dentate, owing to thin and highly chitinised extensions of the body-wall below the large pores.

Female, second stage. Pygidium (fig. 27, *d*) with a pair of strongly tricuspid, median lobes; marginal extensions similar to those of the adult but fewer in number.

Male puparium. Thickly felted and generally with a faint median carina. Pellicle bright orange yellow.

British East Africa: Kabete, on wild fig tree, 7.i.14 (*T. J. Anderson*).

Explanation of Plate VI.

Lecanium hesperidum (Linn.) ♂.

Fig. 1. Adult.

1*a*. Head, dorsal view.

1*b*. Head, ventral view.

2. Terminal segment of antenna.

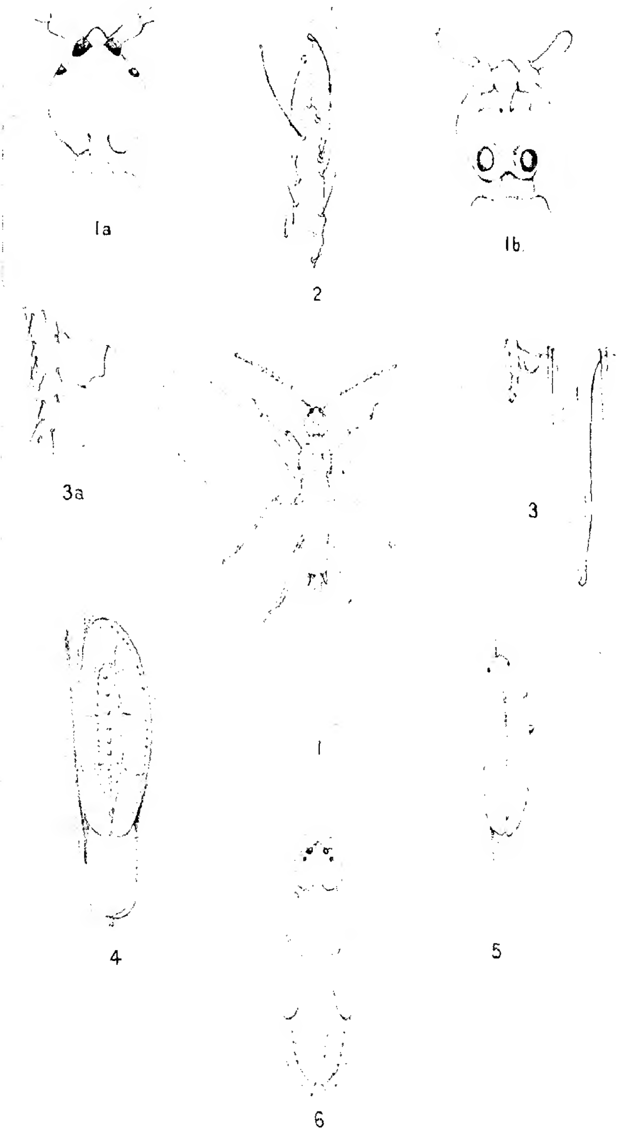
3. Terminal segment of abdomen.

3*a*. Terminal fleshy tubercle and gland, more highly magnified.

4. Puparium, with the insect emer ing.

5. Male, second stage.

6. Pupa.



THE MALE OF *LECANIUM HESPERIDUM* (Linn.)

Explanation of Plate VII.

Pimento Trees in Jamaica attacked by Scale insects (*Aspidiotus pimentae*, Newst., sp. n.).

Fig. 1. Scale attacked by the fungus *Myriangium duriaei*, Mont. & Berk.

2. Abnormal shedding of bark by an attacked tree. The trouble gradually gets worse, until the tree becomes bark-bound. The scales remain on raised islands of live uncast bark tissue.

3. Tree dying from attacks by scales.

Fig. 1.

Fig. 2.

Fig. 3.

ON SOME RHYNCHOTA OF ECONOMIC IMPORTANCE FROM COLOMBIA.

By W. L. Distant.

(Plate V.)

The Imperial Bureau of Entomology have received the following six species of Rhynchota from Colombia, forwarded by Mr. M. T. Dawe, the Director of Agriculture, who reports two of them *Trichocentrus* sp., and *Collaria oleosa* as injurious to rice plantations, and the remaining four, *Monalonion atratum*, *M. illustris*, *M. megiston*, and *M. collaris* as damaging cacao pods. Of these Monalonions, two are here described as new species.

Fam. LYGAEIDAE.

Sub-fam. Colobathristinae.

Trichocentrus gibbosus ? (Pl. v, fig. 3).

Trichocentrus gibbosus, Horv., Ann. Mus. Nat. Hung, 1903, pp. 119 and 153.

Dr. Horvath proposed this new genus for a species he described from the Rio Grande, and Mr. Dawe's specimens, from the character "pronoto antice tumido-elevato, capite multo altiore," seem to belong to the genus and possibly to the same species. The present war however prevents any comparison or loan of types.

Mr. Dawe reports that the species above referred to "attacks rice plantations."

Fam. CAPSIDAE.

Genus Collaria.

Collaria, Provancher, Nat. Canad. iv, p. 79 (1872).

Nabidea, Uhler, Proc. Bost. Soc. Nat. Hist., xix, p. 397 (1878); Reut., Zool. Jahr., Arthr., p. 507 (1879).

Trachelomiris, Reut., op. cit., p. 238.

Collaria oleosa (Pl. v, fig. 6).

Trachelomiris oleosus, Dist., Biol. Centr. Amer. Rhynch. Het., i, p. 238, pl. xxiv, fig. 2 (1883).

Collaria oleosa, Dist., op. cit., p. 417 (1893); Van Duzee, Check List Hem. Amer. N. of Mexico, p. 35 (1916).

Hab. N. America: Western Texas to Southern California. Throughout Central America; Venezuela; Colombia (*M. T. Dawe*).

Attacks rice plantations in Colombia.

Genus Monalonion.

Monalonion, Herr.-Schäff., Wanz. Ins. ix, p. 168 (1853); Sign., Ann. Soc. Ent. Fr. (3) vi, p. 500 (1858); Dist., Biol. Centr. Am. Rhynch. Het. i, p. 246 (1883).

In Central America, Mr. Champion frequently found species of this genus in the withered leaves of the banana (*Musa* sp.).

Monalonion atratum, var. (Pl. v, fig. 1).

Monalonion atratum, Dist., Biol. Cent. Am. Rhynch. Het. i, p. 247, pl. xxiv, fig. 14 (1883).

Monalonion pilosipes, Kirk., Tr. Ent. Soc. Lond., 1902, p. 264.

Hab. Central America: Mexico, Panama. Ecuador; Colombia (*M. T. Dawe*).

This species is variable in the colour of the pronotum and scutellum, which in some cases (as in the Colombian specimen here figured) are ochraceous, and Mr. H. H. Smith has sent both the forms as taken *in cop.* (Mexico: Teapa). Another variation in specimens from all localities is in an occasional ochraceous annulation to the posterior femora, as in the figure here given. Kirkaldy, whose type of *M. pilosipes* is now in the British Museum, seems to have relied on the pilosity of the legs, as a character of his species. It was mentioned in the diagnosis of *M. atratum* "legs black and strongly pilose," and in the figure given of this species this character was particularly portrayed.

M. reuteri, Bergr., from Guiana (Ann. Soc. Ent. Belg., 54, p. 67, 1910) is also evidently allied to this species.

Damages cacao pods in Colombia (*M. T. Dawe*).

Monalonion illustris, sp. nov. (Pl. v, fig. 2).

Monalonion atratum, var. ?

Head, antennae, pronotum, and scutellum dark, shining black; base of first antennal joint stramineous; anterior legs ochraceous, apices of femora, bases of tibiae and the tarsi black; posterior legs black, femora annulated with ochraceous (intermediate legs mutilated in type); a central longitudinal fascia to pronotum and scutellum, ochraceous; corium shining black, a spot at base and narrow costal margin ochraceous; membrane dull black, its apex pale fuscous; body beneath black, base of abdomen sanguineous; legs distinctly, somewhat longly pilose.

Long. 10 millm.

Hab. Colombia.

Damages cacao pods (*M. T. Dawe*).

A single specimen of this species has been received. It may prove to be another variety of the preceding species, *M. atratum*, but requires recognition as an economic pest.

Monalonion megiston (Pl. v. fig. 4).

Monalonion megiston, Kirk., Tr. Ent. Soc. Lond., 1902, p. 264.

Hab. Ecuador; Colombia (*M. T. Dawe*).

Damages cacao pods (*M. T. Dawe*).

Monalonion collaris, sp. nov. (Pl. v, fig. 5).

Head and pronotum shining black, the latter with an anterior transverse ochraceous collar; scutellum ochraceous, with two large lateral black spots; antennae black; corium ochraceous, with a large transverse black fascia near base of membrane; membrane black, with a broad transverse ochraceous fascia on basal half; head beneath and sternum black, anterior and intermediate legs ochraceous, posterior legs black, the femora broadly annulated with ochraceous; rostrum blackish, its apex ochraceous; abdomen beneath ochraceous, basal and apical areas, more or less centrally connected, black; first joint of antennae moderately globose; head centrally depressed between the eyes; pronotum roundly moderately gibbous.

Long. 14 millm.

Hab. Colombia.

Damages cacao pods (*M. T. Dawe*).

Explanation of Plate V.

Fig. 1. *Monalonion atratum*, Dist., var.

2. *Monalonion illustris*, Dist., sp. n.

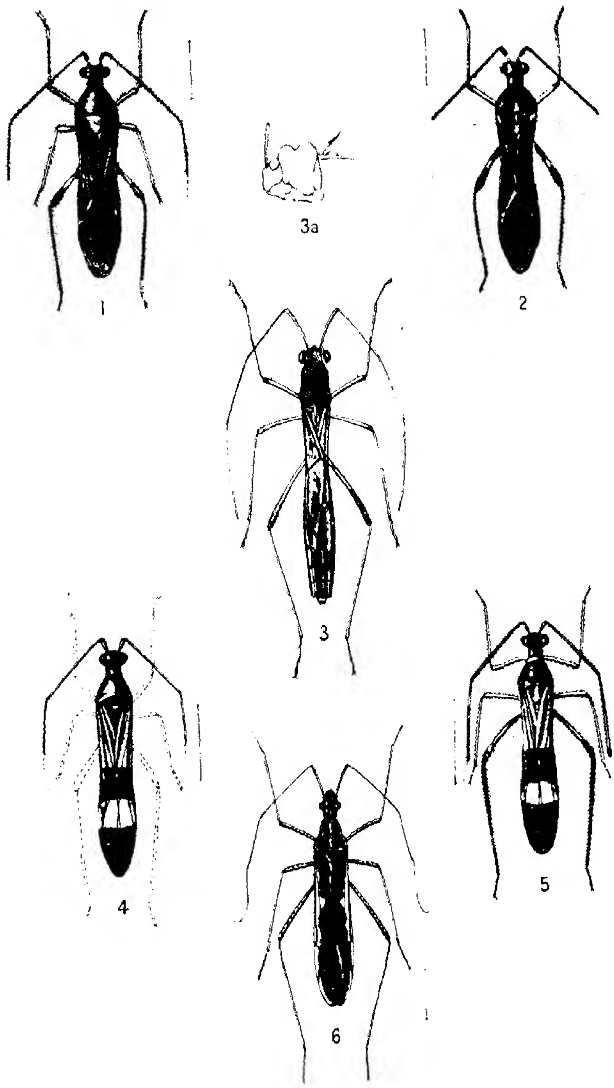
3. *Trichocentrus ? gibbosus*, Horv.

3a. *Trichocentrus ? gibbosus*, Horv. profile view of head and prothorax.

4. *Monalonion megiston*, Kirk.

5. *Monalonion collaris*, Dist., sp. n.

6. *Collaria oleosa*, Dist.



INJURIOUS RHYNCHOTA FROM COLOMBIA.

INSECTS INJURIOUS TO VEGETATION.

By W. F. Fiske.

In 1837 a commission established by the State of Massachusetts to conduct a botanical and zoological survey was instructed by Governor Everett in the following terms :—

"It is presumed to have been a leading object of the Legislature, in authorizing this survey, to promote the agricultural benefit of the Commonwealth, and you will keep carefully in view the economical relations of every subject of your inquiry. By this, however, it is not intended that scientific order, method or comprehension should be departed from. At the same time that which is practically useful will receive a proportionately greater share of attention than that which is merely curious; the promotion of comfort and happiness being the great human end of all science."

Dr. Thaddeus William Harris, librarian of Harvard College, and an amateur entomologist of unusual understanding, was asked to survey and to report upon the insect fauna of the State. At that time the majority of the species were undescribed, and the task was stupendous. To quote his own words :—

"I was deterred from attempting to describe all these insects by the magnitude of the undertaking, and by the consideration that such a work, much as it might promote the cause of science, if well done, could not be expected to prove interesting or particularly useful to the great body of the people. The subject and plan of my report were suggested by the instructions of the Governor, and by the want of a work combining scientific and practical details on the natural history of our noxious insects. From among such of the latter as are injurious to plants I selected for description chiefly those which were remarkable for their size, for the peculiarity of their structure and habits, or for the extent of their ravages; and these alone will be seen to constitute a formidable host. As they are found, not only in Massachusetts, but throughout New England, and indeed in most parts of the United States, the propriety of giving to the work a more comprehensive title than it first bore becomes apparent."

The title finally selected was "A Treatise on some of the Insects Injurious to Vegetation." The treatise itself was the first considerable contribution to the literature of economic entomology in America in which any attempt was made (to quote again the words of His Excellency, Gov. Everett) to keep "carefully in view the economical relations of the subject" without "departing from scientific order, method and comprehension." It represents the corner stone in the foundation of the modern science of economic entomology.

In the all too brief introductory paragraphs Dr. Harris defines the aims and scope of economic entomology in the following words :—

"The benefits which we derive from insects, though neither few in number nor inconsiderable in amount, are, if we except those of the silk-worm, the bee and the cochineal, not very obvious, and are almost entirely beyond our influence. On the contrary, the injuries that we suffer from them are becoming yearly more apparent, and are more or less within our control. A familiar acquaintance with our insect enemies and friends, in all their forms and disguises, will afford us much help in the

discovery and proper application of the remedies for the depredations of the former, and will tend to remove the repugnance wherewith the latter are commonly regarded.

"Destructive insects . . . are exposed to many accidents through the influence of the elements, and they fall a prey to numerous animals, many of them also of the insect race, which . . . contribute to prevent the undue increase of the noxious tribes. Civilization and cultivation, in many cases, have destroyed the balance originally existing between plants and insects and between the latter and other animals. . . . The destruction of insect-eating animals, whether quadrupeds, birds or reptiles, has doubtless tended greatly to the increase of insects. Colonization and commerce have to some extent introduced foreign insects into countries where they were before unknown. It is to such causes as these that we are to attribute the unwelcome appearance and the undue multiplication of many insects in our cultivated grounds, and even in our store-houses and dwellings. . . .

"To understand the relation that insects bear to each other and to other objects, and to learn how best to check the ravages of the noxious tribes, we must make ourselves thoroughly acquainted with the natural history of these animals. This subject is particularly important to all persons who are engaged in agricultural pursuits. For their use, chiefly, this account of the principal insects that are injurious to vegetation in New England has been prepared."

I venture to assume that this statement of the case would be approved by the majority of the economic entomologists of to-day. The same arguments have been put forward many times to emphasize the desirability or need of establishments for research into the natural histories of the "noxious tribes" of insects, and the lines suggested by Dr. Harris have been followed assiduously.

But although we have accepted the arguments and conclusions adduced by Dr. Harris, and have modelled our system for the acquisition and application of knowledge accordingly, our conception of the relations which species bear to each other and to other objects is fundamentally different from his. His arguments, conclusions and recommendations were based upon the pre-Darwinian or Mosaic conception of the origin of species, and any theory or hypothesis which might be formulated concerning the character of their relations to each other and to their physical environment was necessarily in accord with what now appears to us an archaic and impossible point of view. This is sufficiently indicated by the following further quotation from the introductory paragraphs to Dr. Harris' report. (The italics are mine.):—

"Destructive insects *have their appointed tasks* and are limited in the performance of them; they are exposed to many accidents through the influence of the elements, and they fall a prey to numerous animals, many of them also of the insect race, which *while they fulfil their own part in the economy of nature*, contribute to prevent the undue increase of the noxious tribes. Too often by an *unwise interference with the plans of Providence* we defeat the very measures *contrived for our protection*. We not only suffer from our own carelessness, but through ignorance fall into many mistakes. . . . Deprived of their natural food by the removal of the forest trees and shrubs that once covered the soil, *insects have now* NO OTHER RESOURCE than the *cultivated plants* that have taken the place of the original vegetation. . . . We *have no reason to believe that any absolutely new insects are created or generated*

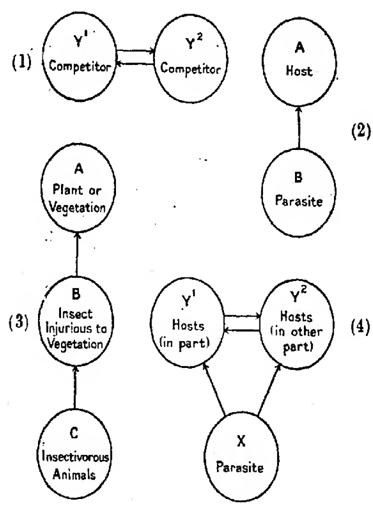
from time to time. The supposed new species, made known to us first by their unwonted depredations, may have come to us from other parts, *or may have been driven by the hand of improvement from their native haunts*, where heretofore the race had lived in obscurity, and had thus escaped the notice of man."

It is thus indicated that although Dr. Harris recognised the existence of a natural balance between plants and insects and between insects and other animals, he did not attribute it to the working out of natural law, which might be codified and understood, but to a "plan of Providence," specially "contrived" for the protection of mankind. He saw no reason to believe that new species of insects were generated or created from time to time, but did not deny the possibility. Were it to occur, the circumstance would be comparable to the introduction of a new species into a region where it was before unknown, and this, according to Dr. Harris, might result in forcing a new mode of life upon indigenous species. Twice in the two pages of his introduction he refers to insects having been driven forcibly from their native haunts, and impelled to live elsewhere, much as individual men and women were driven from England to form colonies in America, and from the newly formed colonies to found yet others, deeper in the wilderness. He was strongly impressed with the idea that after a species had been as arbitrarily created and introduced into the world as an European insect is arbitrarily transported across the Atlantic and introduced into America, it was constrained to live somehow, by divine decree. If its food-plant were exterminated, it would enforcedly attack another; or if the forest were destroyed, it would enforcedly live in the plantations of the colonists; but being supernaturally created, and ordained to live and to perform appointed tasks, it could not die except it were the will of its Creator, or of the demi-god man. Questions of environment and "natural control" of species were all answered by the Mosaic doctrine of supernatural origin, which implies either supernatural or artificial* control of their destinies subsequently.

From the point of view that man is only a little lower than the angels, and that the whole world, and all that there is of good in it was specially contrived for him, and his enjoyment, there is no other explanation for the plagues of noxious insects than that they represent the machinations of a spirit of evil; of Beelzebub, the god of flies, or of the devil, who tempted Eve, and who survived to torment the souls of medieval Europeans and of their descendants in Colonial America. The ancient, and generally entertained, belief that such plagues of insects are the products of devilish ingenuity might or might not have been repudiated by Dr. Harris, but it was wide-spread in ancient times, and has survived to this day, in some respects hardly modified by the philosophy of Lamarck and Darwin. We have never succeeded in expurgating our literature, our manner of speech, and our methods of reasoning, of the ancient dogma which assumes the existence of implacable and incorrigible evil, diametrically opposed to implicit and invariable good, both of which are innate and absolute. Hence we were advised and have endeavoured consistently with this advice, to separate plants, insects and other organisms into two categories, corresponding to good and evil; good if they were or appeared to be beneficial to the best (*i.e.*, to the human species),

* Man being super-naturally endowed, artificial control of other species would be super-natural.

Competitive enmity between two individual organisms, or two species, might be indicated diagrammatically as in Fig. 1. The arrows indicate that enmity is mutual, and in any conflict along such lines the better or the stronger individual or species wins. Parasitic or predatory enmity is indicated as in Fig. 2. It is one-sided. The parasite may be the enemy of the host, but the latter cannot be considered as the enemy of the parasite or predator which depends upon it for subsistence. The relations between plants and insects, and between insects and other animals, to which Dr. Harris calls



our attention are those which correspond to Fig. 2, and which may be presented more specifically in Fig. 3. He did not recognise competitive enmity. But we certainly cannot secure a clear conception of the relations between different species and between species and their environment unless the struggle for existence between competitors is recognised. This can be done by combining Figs. 1 and 2 to form Fig. 4, in which the parasite is seen to menace competing hosts. Then, whenever natural enmity of the parasite towards its competing hosts is unequally displayed the parasite is very likely to become the real enemy of the one, and the real friend of the other.

This principle certainly applies to the inter-relations between all plant and animal species, and therefore to the relations between insects and their plant hosts on the one hand and their parasites and predatory enemies on the other. It serves as an explanation for many otherwise obscure phenomena, such, for example, as the disappearance of the American cabbage butterfly from the larger portion of its range following the introduction of a European competitor. Other and numerous examples of its working out were encountered in connection with the attempts to introduce into America the parasites and other "natural enemies" of gipsy and brown-tail moths. The best examples, however, are to be found in connection with insects in their relation to plants.

Competition between plants is normally very active. As a result any insect species which subsist parasitically at the expense of a plant species may easily bring about complete extermination of the host plant; not through direct injury, so much as indirectly, by permitting a competing plant species to secure an advantage. A striking case in point is afforded by the gipsy moth in its relations to pine and oak. It is injurious to both, but is ordinarily more injurious to oak than to pine. The two trees are active competitors for space in which to grow in many localities in New England where the gipsy moth has been in a state of outbreak, and where the oak until recently held the upper hand. In such localities it has not infrequently happened that, although the pine trees have been injured to some extent, the pine species has benefited in the end and through the oak species having been injured to a proportionately greater extent. The lives of countless pines have been saved, under certain circumstances and conditions, by the activities of an insect which, under other circumstances and conditions, has proved itself to be a dangerous enemy of trees. "Vegetation" has not been injured by the gipsy moth; only some plants and trees have been injured to the benefit of their competitors.

It may not, therefore, be assumed that, because insects are at times injurious to plants, phytophagous insects as a class are to be considered as generally injurious rather than beneficial to green plants as a class, or to vegetation. Such an assumption appears not to accord with fact, nor with the theory of natural evolution and natural control of species, but to have been a logical outgrowth of a belief in supernatural origin and supernatural control. The phrase selected by Dr. Harris as a title for his treatise is aphoristic, and means little more than that insects are sometimes injurious, to plants of economic value, and thereby become obnoxious to man. On the whole the insects inhabiting a tract of woodland are less injurious to vegetation than a boy weeding a carrot bed, or a man pruning an orchard, or cattle grazing in a pasture. With a few exceptions (such as may be afforded by migratory locusts and other very indiscriminate feeders), insects are as beneficial as they are injurious to vegetation, wherever plants are actively competing among themselves for space in which to grow, and this means in most of the well-watered, moderately fertile localities in the temperate and tropical regions.

The phrase "insects obnoxious to man" is equally open to criticism. The race class and condition of the men, and the conditions and circumstances prevailing at the time and place, have all to be considered. If all mankind is meant to be included, all men must be included, and it may easily be that a large number will be benefited by the misfortunes of a small number.

INSECTS INJURIOUS TO MAN AND STOCK IN ZANZIBAR.

By W. M. Aders.

Order DIPTERA.

Culicidae.

Zanzibar Town is roughly divided into two halves, the European quarter, with the Indian Bazaar, and the native African town, these two districts being separated by a tidal creek. The European quarter (where most of the Government officials and Europeans reside) is on the western side in close proximity to the sea. The periphery of the town is surrounded on the land side by various swamps, all of them potential mosquito-breeding areas during certain seasons of the year, some of them permanent throughout the year.

There are two rainy seasons during the year; the heavy rains generally commence about the middle of April and last until the end of May or the first week in June. The rainfall for April, May and June during the last three years was as follows:—

	1913	1914	1915
April	17·59	12·69	9·62
May	11·18	3·84	10·30
June	0·07	0·88	5·00

The small rains break about November and are of three weeks duration. These two rainy seasons greatly influence the prevalence in town of *Anophelinae* and various species of *Culicinae*. During the dry season *Anophelinae* are of rare occurrence in the town, one might say practically non-existent, judging by the mosquito brigade returns. There are certain permanent Anopheline breeding grounds outside, and on the periphery of the town; shortly after the rains set in, a chain of small swamps, pools, etc., are brought into being, which act as intermediate breeding grounds for Anophelines and are responsible for their eventual arrival in the town. During May and June Anopheline larvae are found in small numbers throughout the town; as their breeding grounds dry up the adults die off, to reappear during the next rainy season.

The following table shows the catches of Anopheline larvae in the town during April, May and June for the last three years:—

	1913	1914	1915
April	3	3	2
May	14	8	9
June	5	7	4

To sum up the position. During certain periods of the year Anophelines gain entrance to the town through a line of small collections of water formed by the rains; these temporary breeding places soon dry, with the result that most of the adult Anophelines in town die. There are permanent breeding grounds outside the town which constitute the real home of these mosquitos.

For the purpose of controlling mosquito larvae, several of the larger swamps on the periphery of the town have been drained, others brought into existence during the rainy season are oiled, and a mosquito brigade works under the supervision of the medical officer of health.

During the last few years three kinds of traps have been used for collecting larvae of Anophelines, Culicines and Stegomyias, respectively. The Anopheline trap consists of a flat tub about six inches in height filled with rain-water and algae, with a small layer of earth sprinkled on the bottom. The Culicine trap consists of a half barrel filled with water rich in decaying vegetation; the addition of cess-pool water, rice or other organic material forms an attractive bait. The Stegomyia trap is made in the same way as the former, being filled with clean rain-water. I am of opinion that if these traps were used on an extensive scale, they would undoubtedly prove of great use as one method of mosquito eradication.

Fish imported from the Seychelles (*Haplochilus playfairii*) have been of some use in wells and tanks containing clear water and affording little other animal food. Numbers have been placed in various permanent swamps, their efficacy is still undecided.

As regards the work of mosquito destruction in the town, the great problem is the control of *C. fatigans*, the most prevalent mosquito according to indices of adults taken in the various quarters. Whenever cesspools are opened and examined numbers of *C. fatigans* larvae are found, generally in pure culture, except in cases where the water is very foul, when the larvae of *Pericoma meridionalis* reveal themselves. These small PSYCHODIDAE are a common feature in bathrooms and closets throughout the town.

Practically all houses are furnished with cesspools and cesspits, those of Europeans being provided with earth-closets on the bucket system. The cesspools contain kitchen, bath and household waste water, and in some instances receive a certain amount of storm water. Generally an opening leads from the pantry on the ground-floor direct into the cesspool, affording easy entry for adult mosquitos; the roofs of the cesspools are also often faulty, thus providing entry for mosquitos.

Larvae of *S. fasciata* are found throughout the town area, particularly in native huts, where water is stored in large earthenware jars, but also in the iron drums and water-barrels of the Indian bazaars and European quarters. The careful collection of adult mosquitos in houses and their detailed classification and enumeration has proved of the greatest value in the search for and the control of breeding places.

The following natural enemies of mosquitos have been recorded:—

Larvae of dragon-flies, water-bugs (many species), and larvae of various aquatic Coleoptera. Experimentally the aquatic bugs have proved to be the most rapacious. Nightjars, bats and various species of spiders belonging to the family ATTIDAE prey on the adults.

The Mosquitos of Zanzibar Town.

Anopheles costalis, Lw. The only Anopheline taken in the town area. Larvae are generally found in shallow pools rich in decaying vegetation and algal growth, occasionally in water fountains, tin drums, rain-water left in dug-out canoes and crab-holes. They are able to thrive in pools exposed to direct sunlight. Larvae in captivity are difficult to rear, unless under suitable and natural conditions; many become infested with *Vorticella* and speedily succumb to this infection. This is the common vector of malaria in Zanzibar, and sporozoits have been found on several occasions in the salivary glands. *A. funestus*, a much rarer species, has not yet been found infected, but only a small number of adults have been captured.

Stegomyia fasciata, F. This species is to be found everywhere, breeding under the most varied conditions, generally in household utensils, old tins, earthenware jars, etc. They show a marked preference for clear water, being rarely taken in association with *Culex fatigans*. Some of their rarer haunts are holes in mango trees and slots cut in the trunks of coconut palms to facilitate climbing. The larvae of *S. fasciata* are very hardy and able to exist in water with a very poor food supply. Experimentally larvae mature and pupate in water to which 2% of sea-water has been added. Adults fed on a patient showing numerous microfilariae (*Filaria bancrofti*) in his peripheral blood exhibited microfilariae in the thoracic muscles nine days afterwards. Specimens of *S. fasciata* have been captured on several occasions showing a natural thoracic infection with microfilariae.

Stegomyia vittata, Big. (*sugens*, Theo., nec Wied.). Larvae were found on one occasion in a large dirty pool in a poultry run.

Culex fatigans, Wied. The commonest mosquito in all quarters of both towns. The larvae are nearly always found in water rich in decaying animal or vegetable matter, and are very common in cesspools. Large numbers of adults have been found to contain microfilariae (*Filaria bancrofti*), showing both thoracic and proboscis infections. Experimentally these mosquitos are difficult to feed in captivity, as they do not bite at all readily; they feed better about an hour before dawn. Larvae thrive and pupate in water to which 1% of common bar soap or 1% human urine has been added.

Culex tigripes, Grp. A considerable number of these useful larvae have been taken throughout the town in association with *C. fatigans*, *S. fasciata* and *A. costalis*, They are capable of destroying large numbers of mosquito larvae; I have seen two adult larvae destroy thirty *Stegomyia* larvae in an hour. Adults have never been taken in houses, and in captivity will not feed on blood. In a mixed collection of larvae *C. tigripes* can be easily detected by their almost Anopheline position in the water and generally white colour.

Eretmopodites quinquevittatus, Theo. Larvae are common in small dirty collections of water, especially in empty Molluscan shells; those of the land snail, *Achatina panthera*, nearly always harbour a number of these larvae. Adults have never been captured in houses, but are common in low bush and wooded areas. I have never been able to induce adults to feed on human blood in captivity. They partake greedily of banana and dates, and when fed on such a diet females have been shown to lay fertile eggs. The eggs, which are of a dark brown colour, are laid

singly. The larvae are easily recognisable by the long narrow abdomen and thorax, short syphon, and the peculiar habit of gliding and not wriggling as a means of progression through the water. By this characteristic they are easily singled out from a mixed sample. The pupae are generally white in colour; the abdominal segments, instead of being coiled upwards towards the thorax, hang vertically downwards; conspicuous tufts of bristles attached to the anal fins are recognisable with the naked eye.

Eretmopodites chrysogaster var. *subsimplicipes*, Edw. A few specimens taken with and under the same conditions as *E. quinquevittatus*.

The Mosquitos of Zanzibar and Pemba Islands.

Anopheles costalis, Lw. This is the most abundant Anopheline in the island and has been found in every district. Larvae have been captured under very varied conditions, generally in small swamps and occasionally at the edges of large lakes and rivers. They seem to show a marked preference for the water in the shallow surface wells which are dug by the natives all over the island, this water being of a distinctly milky appearance from suspended clay. Some of their rarer haunts are brackish coral rock-pools, crab-holes, etc.

Anopheles funestus, Giles. Adults are common in native huts in outlying districts in proximity to flooded rice-fields; several have been taken in houses belonging to Europeans in Pemba. Larvae are generally found in flooded rice-fields and in large shallow swamps, also in backwaters of various rivers.

The distribution of this Anopheline is nothing like so general as that of *A. costalis*.

Anopheles mauritianus, Grp. Wild adults have never been captured. The larvae inhabit large swamps, often in association with *A. costalis* and *A. funestus*. They are easily recognised by their conspicuous abdominal banding and their habit of twisting themselves into an S formation while on the surface of the water.

Anopheles squamosus, Theo. Larvae have been taken in various large swamps in association with *A. mauritianus* and *Culex laurenti*. I am unable to distinguish between the larvae of this form and that of *A. mauritianus*.

Stegomyia fasciata, F. As mentioned before, one of the commonest forms in the town. It has been recorded from every district in the island; several islands at a considerable distance from Zanzibar are heavily infested.

Stegomyia vittata, Big. A rare form, I have only two records of breeding places.

Stegomyia metallica, Theo. Has been captured in various localities; in every instance the larvae were obtained from holes in African almond trees (*Terminalia catappa*) and mango trees.

Stegomyia simpsoni, Theo. Like the last-named species, found breeding in African almond trees, but not so prevalent. A few were taken in an earthenware pot in association with *S. fasciata*.

Culex fatigans, Wied. Distributed all over the island.

Culex invidiosus, Theo. Common in swamps in association with *Anopheles costalis*.

Culex tigripes, Grp. Common all over the island. The larvae are capable of living under the most varied conditions; I have found them in swamps, old tins, water-holes and in holes in trees.

Culex laurenti, Newst. Larvae abundant in swamps and water-holes, often in association with *A. costalis*.

Culex decens, Theo. Larvae have been taken in various breeding places, such as old tins, water-holes, road puddles, etc.

Culex univittatus, Theo. Larvae from rice swamps in association with *Anopheles funestus*.

Culex sitiens, Wied. A common species; adults have been captured in native huts in numerous villages.

Culex duttoni, Theo. Has a wide distribution. The larvae are easily recognisable by the dark ring near the apex of the siphon and its peculiar torpedo-like shape.

Culex perfuscus, Edw. Adults were captured in a cell in the central jail, the females being heavily engorged with blood. The jail is outside the town.

Culex simpsoni, Theo. Larvae were found in swamp water in company with a large number of other species, including *Anopheles costalis*.

Culex insignis, Cart. One record from a swamp area outside the town.

Culex tritaeniorhynchus, Giles. One record from an area outside the town.

Culiciomyia nebulosa, Theo. An extremely common form, and a very troublesome biter; larvae have been obtained from swamps and domestic utensils. A constant characteristic of the larva seems to be the six pairs of hair-tufts on the siphon.

Ochlerotatus pembaensis, Theo. Adults have been taken all along the sea-shore for several miles in proximity to the town; they are virulent biters. In Weti, the capital of Pemba Island, they are one of the commonest house mosquitos. Larvae abound in crab-holes and depressions close to high-water-mark, and are able to withstand a high degree of salinity; I have never found them actually in sea-water. Experimentally they thrive in water to which 80% of sea-water has been added. This species seems to be confined to the sea littoral, as we have no records of larvae from inland waters. The larvae are long-lived and grow slowly, the average length of life under normal conditions being 12 to 14 days. The characters of the larva are as follows:—

Head small, light brown in colour, with one small plumed hair above the eye. Antennae long, cylindrical, with hair-tuft on the dorsum of the basal joint and single long hairs at its apex. Thorax with long plumose hairs; the median tufts set in chitinous sclerites are remarkably long, being easily visible to the naked eye, and help to distinguish this form in a mixed collection. Abdomen with long plumose hairs on the first two segments, the remainder with single hairs. Comb difficult to see, triangular in outline, with a large number of pronged teeth. Siphon about as long as the 7th and 8th abdominal segments, not markedly pointed; pecten with 12 teeth, the 6 basal ones short. Anal segment furnished with a broad prominent beard composed of 8 long plumes.

Ochlerotatus durbanensis, Theo. A small series bred from larvae obtained from a rain-water pool in the neighbourhood of the town.

Ochlerotatus nigeriensis, Theo. Larvae obtained from rain pool in association with *A. costalis*.

Ochlerotatus longipalpis, Grünb. All larvae of this species have been obtained from holes in mango trees in association with *Toxorhynchites brevipalpis*. The larvae have a peculiar faint rose colour, and are easily recognised by their habit of hanging suspended for considerable periods of time in the middle of their breeding water. All attempts to feed adults on human blood failed. The characters of the larva are as follows :—

Head large, dark brown in colour, with prominent well-developed brushes, the lateral clypeal hairs bifurcated ; maxillae well developed, pendant and supplied with brushes. Antennae long, cylindrical, with one hair near the apex of the basal joint. Thorax small in comparison with the head, having the usual plumes, the median one slightly longer than the others. Abdomen with plumes on the first two segments ; the comb composed of 30 to 40 small scales. Siphon straight, as long as the 6th, 7th and 8th segments ; pecten with 26 teeth.

Ochlerotatus fulgens, Edw. A few specimens were bred from larvae captured in a hole in a mango tree, and were mistaken for *O. longipalpis*.

Ochlerotatus irritans, Theo. Has been taken from various localities, chiefly in large swamps.

Ochlerotatus albocephalus, Theo. One record.

Ochlerotatus adersi, Edw. Larvae were taken in holes in African almond trees in association with *Stegomyia metallica*.

Eumelanomyia inconspicuosa, Theo. Larvae obtained under the same conditions as the former species.

Banksinella lineatopennis, Ludl. A rare form, represented in our collection by two specimens.

Cyathomyia fusca, Theo. Larvae taken in tree-holes.

Eretmopodites quinquevittatus, Theo. As previously mentioned, common in the town, also recorded from various out-districts.

Eretmopodites chrysogaster var. *subsimplicipes*, Edw. A few specimens taken with *Eretmopodites quinquevittatus*.

Mansonioides uniformis, Theo. No records from Zanzibar, but several adults have been captured on the island of Pemba in association with *Anopheles funestus*.

Toxorhynchites brevipalpis, Theo. Ubiquitous ; we have specimens from many localities, including the town. Nearly every mango tree with holes in the trunk harbours from three to eight larvae. They are predaceous on larvae of *A. costalis*, *S. fasciata*, and *C. fatigans* ; but as these three species are rarely found under such conditions, the *Toxorhynchites* is not of much practical value.

Mimomyia mimomyiaformis, Newst. Recorded from one locality.

Mucidus mucidus, Karsch. Adults have been taken in houses in close proximity to the town. Larvae were found on only one occasion, in an old cement tank containing water rich in decaying vegetation.

Taeniorhynchus fuscopennatus, Theo. Adults have been captured in houses in Pemba, the females heavily engorged with blood. No specimens have been recorded from Zanzibar Island.

TABANIDAE.

Many species of these flies have been taken from various districts in both islands (Zanzibar and Pemba). They are found in abundance in wooded areas close to streams or marshes. I have captured very few species in open arid or grassy country. One record exists of a capture of two *Tabanus biguttatus* in the Government stables in the town. Their prevalence varies with the seasons, and they are very abundant for about six weeks after the rains. Ideal weather conditions are slight showers of rain with sunny interludes; on such a day the bag is always full. During heavy rain or high wind they are conspicuous by their absence.

TABANIDAE have not been definitely implicated in the spread of disease in Zanzibar, but there is a certain amount of evidence that they are capable of acting as vectors of *Trypanosoma pecorum*, the common trypanosome of stock in the island. Repeated efforts have been made to prove this experimentally; but owing to the extreme difficulty of keeping these flies alive in captivity and inducing them to bite experimental animals, no results have been forthcoming.

Tabanus taeniola, P. de B. This is the commonest Tabanid in the two islands, being found everywhere. They often attack man, flying on board the mail steamer while anchored at Pemba and inflicting severe bites on the passengers and crew. When alighting on cattle they nearly always select the lumbar region, seldom the legs. Engorgement averages 2½ to 3 minutes. In mixed herds of cattle and domesticated buffaloes the latter are always singled out for attack, as they seem more callous to the bites.

Tabanus taeniola var. *variatus*, Walk. This variety has only been taken occasionally, the typical *T. taeniola* being the common form.

Tabanus fraternus, Macq. A very common species, being found throughout the two islands. They often attack man, their feeding habits being like those of *T. taeniola*.

Tabanus par, Walk. This small species has a wide distribution throughout the two islands. It nearly always feeds on the withers and hocks of cattle.

Tabanus gratus, Lw. Quite a common species; large numbers have been taken in various districts on both islands.

Tabanus africanus, Gray. This handsome insect is by no means common, and its distribution and prevalence seem to be influenced both by season and environment. All records of capture are shortly after the rains and only in districts where streams are prevalent.

Tabanus biguttatus, Wied. A common species. It generally feeds on the hump of cattle, seldom attacking any other part. Engorgement in some cases took 4½ minutes. Males were taken on tree-trunks in proximity to grazing grounds.

Tabanus conspicuus, Ric. A rare species; only one female has been taken.

Tabanus thoracinus, P. de B. An uncommon form; our collection comprises only four specimens.

Tabanus ditaeniatus, Macq. Nowhere very abundant; all our specimens were taken shortly after the rains.

Tabanus leucostomus, Lw. Represented by two females in our collection.

Tabanus producticornis, Aust. One specimen captured on the sea-shore near a mangrove swamp.

Tabanus albipectus, Big. A few specimens obtained from a sandy bank near the sea-shore.

Aegophagomyia pungens, Aust. A common species along the littoral of both islands. These insects seem to have a marked preference for damp sandy patches, often alighting to drink; in comparison with other species they are but little affected by high wind. I have no record of their attacking man, but on several occasions they have been noticed feeding on goats.

Adersia oestroides, Karsch. Similar in its habits to *Aegophagomyia pungens*; numbers have been taken in close proximity to carcases of cattle. Never known to bite man.

Haematopota decora, Walk. The only species of this genus taken in Zanzibar. It is prevalent throughout the whole year on both islands, and generally feeds on the hocks and withers of cattle; engorgement averages 2½ minutes. This insect lives moderately well in captivity, and has been used on many occasions for transmission experiments.

Chrysops longicornis, Macq. A very common species in both islands, persistent throughout the year. Many specimens were taken in a deep shady valley in Pemba; as many as thirty were captured in a few minutes on one donkey, its withers and hocks being smothered. Once they have started feeding nothing disturbs them, and they must almost be brushed off. Fully engorged specimens are slow of flight, proceeding a few yards, then settling on any convenient foliage. They readily attack man, inflicting painful bites round the ankles.

The following is a chart showing the seasonal incidence of the common TABANIDAE. In all cases the collections were made from two water-buffaloes, two hours being devoting to collecting. The majority were obtained from the Bububu district.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Tabanus fraternus	28	18	—	33	30	20	19	14	13	12	5	18
" *tæniola* ..	13	14	—	46	95	22	22	13	4	19	12	5
" *par* ..	3	1	—	17	17	9	10	1	1	9	5	4
" *gratus* ..	3	2	—	4	11	9	10	2	2	2	8	1
Hæmatopota decora	5	2	—	2	4	6	3	—	3	4	—	—
Tabanus biguttatus	3	—	—	4	2	6	4	—	—	—	1	1
" *africanus*	—	—	—	4	3	1	1	—	—	—	—	1
" *leucostomus*	—	—	—	—	1	1	—	—	—	—	1	—
" *ditæniatus*	—	—	—	—	—	2	—	—	—	3	—	—
Chrysops longicornis	—	—	—	—	1	3	3	—	—	—	—	1
Tabanus conspicuus	—	—	—	—	—	1	—	—	—	—	—	—

Rainfall for the Same Year.

January	0·39	July	0·31
February	1·37	August	0·88
March	9·99	September	2·58
April	17·59	October	4·22
May	11·18	November	3·20
June	0·07	December	1·31

Muscidae.

Stomoxys calcitrans, L. Occurs everywhere in the island where cattle are found. Larvae have been found in recent moist droppings; manure pits swarm at all times of the year with larvae and pupae. Animals somewhat out of condition are especially singled out for attack, and this is a useful diagnostic sign when looking over a herd for a suspected trypanosome case. The following non-biting Muscids have been noticed feeding in association with *S. calcitrans*, licking the droplet of blood left from the Stomoxys puncture:—*Musca domestica*, *Pycnosoma putorium*, and *Biomyia tempestatum*.

Stomoxys nigra, Macq. Not so common as the preceding species, but recorded from numerous localities in both islands.

Lyperosia minuta, Bezzi. These small flies are somewhat local in their distribution, showing a marked preference for open windy steppe country; conditions not favoured by other blood-sucking flies.

Cordylobia anthropophaga, Grünb. The only fly known to cause cutaneous myiasis in man in Zanzibar. Several larvae have been obtained from human beings, others from dogs, rabbits, and guinea-pigs. The pupal stage averages about 19 days.

Musca domestica, L. Found in houses and around rubbish heaps throughout the year, though Zanzibar town is remarkably free from these filth feeders. Their favourite breeding grounds are manure pits containing fermenting horse and donkey dung; I have seldom found larvae in cattle manure.

Lucilia sericata, Mg. A few specimens taken on meat in the public market.

Pycnosoma putorium, Wied. Abounds at all seasons of the year in the public markets, being especially attracted to fish stalls and less prevalent on meat. Larvae are found in garbage containing decomposing meat and fish. I have noticed them only occasionally feeding on human ordure.

Pycnosoma marginale, Wied. Not so numerous as *P. putorium*, but commoner on the meat stalls. Breeds in decomposing carcasses and meat.

Pycnosoma bezzianum, Villeneuve. Larvae have been taken on several occasions from donkeys' ears and from sores. In all such cases much destruction of superficial tissue had taken place, associated with pus formation.

Sarcophaga sp. Numbers are always to be found around cess-pits and privies. Larvae abound in rotting meat and carcasses; chicken entrails are generally thrown away carelessly, and if not picked up by crows or cats become a potential breeding nidus for various species of *Sarcophaga*.

Synthesiomyia brasiliana, Br. & B. Large numbers have been bred from decomposing rats' carcasses.

Oestridae.

Oestrus ovis, L. Large numbers of larvae have been taken from the frontal sinuses of goats; in some cases they had penetrated to the base of the horn, but they do not seem to cause any appreciable damage to their hosts. The pupal stage averages 19 days. Very common throughout the island.

Gastrophilus asininus, Br. A few adults have been taken flying around cattle and donkeys.

Drosophilidae.

Drosophila sp. Very prevalent hovering over ripe fruit, in which they breed. At times they alight on meat and human excrement.

Hippoboscidae.

Hippobosca maculata, Leach. Common on cattle, horses and donkeys. The number of Hippoboscids taken has been surprisingly few, and I am of opinion that a moist damp climate like that of Zanzibar is inimical to their development.

Hippobosca capensis, Olf. Has been recorded by a previous collector, I have captured no specimens.

Ornithoeca podicipis, Rod. Taken from a species of heron.

Lynchia maura, Bigot. Common on domesticated pigeons. Numbers of wild pigeons and doves have been examined with negative results.

Cyclopodia greefi, Karsch. Very abundant on flying foxes (*Pteropus voeltzkowi*).

Order SIPHONAPTERA.

Pulicidae.

Xenopsylla cheopsi, Roths. The commonest rat flea; large numbers have been collected from the following species of rats:—*Epimys norvegicus, Mus rattus* and *Mus alexandrinus.* The giant rat (*Cricetomys gambianus*) and a shrew (*Pachyura murina*) are also heavily infested.

Ctenocephalus canis, Curtis. On dogs and in houses in town. Large numbers have been taken from goats, and it occasionally attacks man.

Ctenocephalus felis, Bouché. From cats.

Sarcopsyllidae.

Dermatophilus penetrans, L. Common throughout the two islands; I have taken them on two occasions from dogs.

Echidnophaga gallinacea, Westw. Very common on fowls, the bare parts of the head and the region around the eyes being often thickly encrusted. Several specimens have been taken from the common town rats.

Order RHYNCHOTA.

Cimicidae.

Cimex hemiptera, F. The tropical bed-bug is to be found everywhere throughout the two islands. At times it is a veritable scourge in the prisons.

Cimex lectularius, L. This insect is extremely rare in Zanzibar. Our collection contains a few specimens, all captured from one Goanese, who had resided for some years in the town.

Order ANOPLURA.

Haematopinidae.

Haematopinus tuberculatus, N. Common on domesticated buffaloes.

Liognathus vituli, L. From calf.

Pediculidae.

Pediculus humanus, L. A common pest among Indians, rarely found on native Africans.

Order MALLOPHAGA.

PHILOPTERIDAE.

Nirmus varius, N. From a crow (*Corvus splendens*).

LIOTHEIDAE.

Colpocephalum subaequale, N. From a crow (*Corvus splendens*).

Laemobothrium titan, Piaget. From a kite (*Milvus aegyptius*).

Order ACARINA.

IXODIDAE.

Rhipicephalus appendiculatus, Neum. The commonest species on cattle; undoubtedly the carrier of African coast fever.

Rhipicephalus simus, Koch. Taken on cattle and donkeys.

Rhipicephalus sanguineus, Latr. Very common on dogs.

Rhipicephalus evertsi, Neum. Common on cattle, goats and sheep. Generally found around the anus or in the ears.

Rhipicephalus pulchellus, Gerst. A rare form in Zanzibar. Numbers can be found on cattle imported from the Somali Coast, including replete females. This tick, probably owing to climatic conditions, has been unable to acclimatise itself on the Island; no specimens have been obtained from local stock.

Rhipicephalus maculatus, Neum. From domesticated pig.

Boophilus decoloratus, Koch. Abundant on cattle.

Boophilus australis, Fuller. From local cattle.

Amblyomma variegatum, F. Taken from cattle, goats, sheep and camels.

Amblyomma hebraeum, Koch. A rare species; a few have been obtained from cattle.

Hyalomma aegyptium, L. A number have been collected from camels; on other domesticated animals they seem to be rare. I am inclined to think that this species, like *R. pulchellus*, has been unable to acclimatise itself.

Haemaphysalis leachi, Aud. Very common on dogs.

Haemaphysalis bispinosa, Warb. From imported Indian cows.

My thanks are due to Mr. Guy A. K. Marshall, Director of the Imperial Bureau of Entomology, and the various experts of the British Museum, who have so promptly identified all material submitted to them.

COLLECTIONS RECEIVED.

The following collections were received by the Imperial Bureau of Entomology between 1st October and 31st December, 1916, and the thanks of the Managing Committee are tendered to the contributors for their kind assistance:—

Dr. W. M. Aders:—6 Diptera; from Zanzibar.

Mr. E. A. Andrews:—about 50 Thrips; from Assam, India.

Capt. C. H. Armitage, C.M.G., D.S.O.:—2 *Haematopota*; from the Northern Territories, Gold Coast.

Dr. J. H. Ashworth:—9 mosquitos; from Africa.

Mr. G. E. Bodkin, Government Economic Biologist:—4 Diptera, 34 Hymenoptera, 12 Coleoptera, and 1 sp. of Coccidae; from British Guiana.

Mr. J. R. Bovell, Superindent of Agriculture:—20 Diptera, 77 Hymenoptera, 16 Coleoptera, 8 Termites, 1 Mallophaga, and 14 Thrips; from Barbados.

Dr. H. Brauns:—31 Coleoptera, and 11 Rhynchota; from Cape Colony.

Dr. G. D. H. Carpenter:—1 *Pangonia*, 2 Tabanidae, 1 *Glossina*, 7 other Diptera, 2 Hymenoptera, and 11 Coleoptera; from German East Africa.

Mr. E. C. Chubb, Curator of the Durban Museum:—2 Longicorn beetles; from Natal.

Mr. M. T. Dawe, Director of Agriculture:—4 Tabanidae, 12 *Dermatobia* larvae, 12 other Diptera, 9 Hymenoptera, 3 Lepidopterous larvae and 1 pupa, 53 Coleoptera, 1 sp. of Coccidae, about 300 Aphids, about 36 other Rhynchota, and 84 Ticks; from Colombia.

Division of Entomology, Pretoria:—6 Lepidoptera, 13 Hymenoptera, 53 Coleoptera and 10 Rhynchota; from South Africa.

Mr. P. R. Dupont, Curator of the Botanic Station:—about 35 Lepidopterous larvae, 132 Coleoptera, 18 Coleopterous larvae, 50 Ants, and 30 Mites; from the Seychelles.

Mr. E. D. Easterbrook:—7 ticks off a Lion; from Nyasaland.

The Director, Geneeskundig Laboratory:—29 Mosquitos; from Java.

Mr. G. F. Hill, Government Entomologist:—5 species of Coccidae; from the Northern Territory of Australia.

Imperial Department of Agriculture:—12 *Lachnosterna* beetles; from the British West Indies.

Dr. N. M. Leys:—34 Tabanidae, 1 *Stomoxys*, 3 *Auchmeromyia*, 62 other Diptera, 32 Hymenoptera, and 10 Rhynchota; from Nyasaland.

Dr. J. W. Scott Macfie:—222 mosquitos and a number of larvae and pupae, 12 *Phlebotomus*, 12 *Culicoides*, 23 other Diptera, 2 Coleoptera, 2 Hymenoptera, 2 Hawk moths, 3 sp. of Coccidae, 40 other Rhynchota, and 10 Mites; from the Gold Coast.

Prof. G. H. F. Nuttall, F.R.S. :—10 Tabanidae, and 1 flea ; from Manchuria.

Mr. A. H. Ritchie, Government Entomologist :—2 Tabanidae, 12 other Diptera, 7 Hymenoptera, 2 Moths, 99 Coleoptera, about 50 Aphids, 8 species of Coccidae, 20 other Rhynchota, 6 Orthoptera, 6 Millipedes, and 54 Land Snails ; from Jamaica.

Dr. J. J. Simpson :—58 Mosquitos, 2669 *Glossina*, 12 Tabanidae, 128 Hippoboscidae 122 other Diptera, 15 Coleoptera, 41 Hymenoptera, 2 Rhynchota, and 411 Ticks ; from the Northern Territories of the Gold Coast.

Dr. H. Swale :—80 Coleoptera ; from Samoa.

Mr. R. Veitch :—13 Diptera, 9 Hymenoptera, 4 Lepidoptera, 48 Coleoptera, 52 Rhynchota, and 4 Orthoptera ; from Fiji.

Dr. W. G. Watt, Medical Officer of Health :—424 Mosquito larvae, 2 Coleoptera, and 14 Coleopterous larvae ; from Ashanti.

Wellcome Bureau of Scientific Research :—12 Mosquitos, 2 other Diptera, about 50 Ants, and 305 Lepidoptera ; from Grenada and Venezuela.

Mr. C. B. Williams :—7 Mosquitos, 20 Tabanidae, 63 other Diptera, 491 Hymenoptera, 50 Coleoptera, 30 Rhynchota, 7 Orthoptera, 3 Ticks, 3 Spiders, and 1 tube of intestinal worms ; from British Guiana.

GENERAL INDEX.

Numerals in heavy type indicate that the species is illustrated on that page.

INDEX TO NAMES OF PERSONS.

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